U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

SOIL SURVEY FIELD BOOK.

FIELD SEASON, 1906.

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1906.

JULY.

S.	M.	T.	W.	T.	F.	S.
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1907.

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MAY.

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JULY.

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AUGUST.

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SEPTEMBER.

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OCTOBER.

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NOVEMBER.

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DECEMBER.

S.	M.	T.	W.	T.	F.	S.
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PREFACE.

Two years have elapsed since the publication of the last issue of Instructions to Field Parties and Description of Soil Types. During these years the soils of many new areas have been studied and much additional information in regard to the general relation of the soils of the United States has been obtained. The correlation of the soils is a very difficult problem, and one which can not be definitely solved from the data obtained by the survey of a limited number of widely separated areas. Each additional survey throws new light upon the subject, and sometimes necessitates changes in the soil names used in the earlier reports. The student of soils will doubtless realize that the necessity for such readjustments is an inherent feature of work of this character.

Appreciating the importance of the proper correlation of the soils, Messrs. Macy H. Lapham, Charles N. Mooney, J. E. Lapham, and Hugh H. Bennett—field men of wide experience—were detailed to assist Messrs. George N. Coffey and Jay A. Bonsteel in the revision of this publication. This committee has gone carefully over the reports of all the areas that have been surveyed, compared the descriptions and analyses of the soils, and made such changes as were necessary to bring each soil into its proper place in the classification. Every change made is believed to be a step in advance, no step has been taken except after the most careful consideration of all the questions involved, and it is believed that the subject has been handled in a conservative way.

The present volume is definitive of the state of knowledge at the time of its issuance. However, the collection of data is going on and a fuller understanding of soil relationships is being gained as area after area is mapped. It follows that some changes in the present classification will yet be found advisable, and these will be made as their need becomes apparent. In this way, and only in this way, can a uniform and consistent exposition of the wonderfully varied soil resources of the country be ultimately accomplished.

Milton Whitney,
Chief of Bureau.

Washington, D. C., *May 24, 1906.*

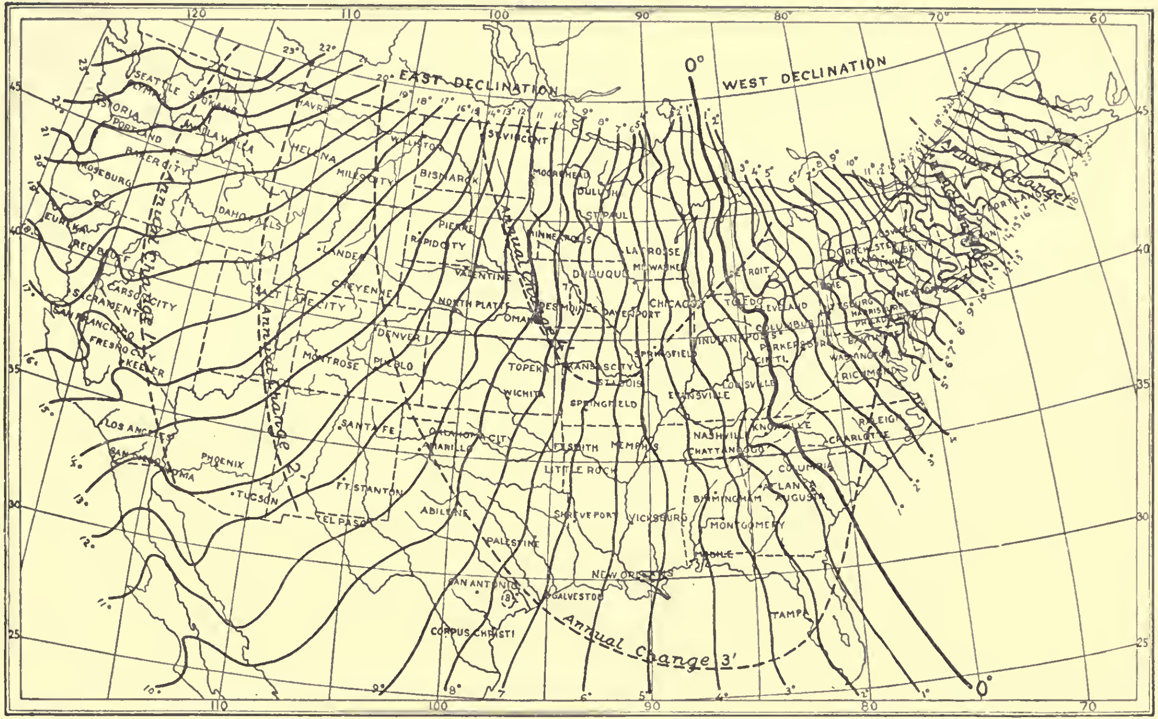

FIG. 1.—Chart of equal magnetic declinations. January, 1902.

CONTENTS.

ILLUSTRATION.

SOIL SURVEY FIELD BOOK.

DIRECTIONS FOR SURVEYING SOILS.

Organization of field party.—A field party in the soil survey usually consists of two men, an assistant in charge of party and a field assistant. The assistant in charge of party is responsible for the field work of the party, for the preparation of reports and maps, for the carrying on of all necessary correspondence, for the payment of all field expenses, and for the forwarding of monthly expense accounts to headquarters. The field assistant will perform all official duties required of him by the assistant in charge.

Field outfit.—The outfit for field work consists of the following:

Soil auger, 40-inch.
Geologist's hammer
Notebooks.
Compass or plane table.
Odometer.
Chain scale.
Set of colored pencils.
Base map.
Sacks and tags for collecting samples of soil.
Cards for reporting samples collected (Forms 46, 47, 48).
Requisition cards (Form 43).
Copy of Soil Survey Field Book.

In addition to the above certain parties should add:

Alkali outfit.
Extension auger and pipe wrenches.
Filter pump and screw-driver.
Metallic tape 50 feet long.
Mailing cases and water bottles.

All supplies may be obtained on application to the property clerk of the Bureau, countersigned by the chief clerk. Memorandum receipts are taken by him for all supplies issued. Additional supplies, stationery, etc., needed while in the field should be ordered on card (Form 43). The loss of or damage to any supplies should be at once reported to the chief clerk, with an explanation of the cause of such loss or damage.

Base map.—All mapping should be on a scale of 1 inch to 1 mile. Where possible base maps on this scale will be furnished all field parties before entering the area. Wherever such maps are supplied it is supposed that they are the most reliable and complete maps obtainable. Field parties should endeavor to correct the base map if it is found in error. Frequent check upon directions should be made with the compass, and all distances on roads are to be measured with the odometer.

Where minor errors are encountered in the base map which can not be corrected, the soil boundaries on the map should be so adjusted as to present a representation as nearly correct as possible, and note of such instances should be made so that in case a revised edition of the map is published the correction can be made without a resurvey of the soils. No attempt should be made to correct the contour lines on engraved topographic sheets.

Plane-table traversing.—It is sometimes impossible to furnish the field party with a base map of proper accuracy. In all such cases the party will be supplied with a plane-table outfit, and a traverse base map of the area should be constructed in the field by the soil-survey party. This traverse work should, however, be reduced to a minimum.

In carrying on traverse work or surveying of any description the methods used, where possible, should conform to well established methods, such as are given in Wilson's Topographic Surveying. The base map should show roads, streams, towns, churches, schoolhouses, and in a sectionized country township and section lines. No attempt should be made to construct a general topographic map of the area, but distinct bluff or terrace lines or the occurrence of a hill in a generally level country, where these influence the distribution of soil types, may be indicated by hachures. Public roads should be shown in double solid lines, secondary or private roads in double broken lines, trails in a single broken line, and soil boundaries in a single dotted line. On tracing cloth copy single lines can be used for all roads. Secondary roads and trails should not be surveyed unless necessary in the location of soil boundaries. Roads and township and section lines should be drawn in black; streams and other water lines in blue.

In order to orient plane-table maps to true north and south, the map on page 4 showing the lines of equal magnetic declination, is given. The solid lines show equal declination and the dotted lines show equal annual change. The lines are moving westward, so that where the declination is east it decreases and where west it increases annually. Whenever it is not possible to determine the declination from the map with a fair degree of accuracy the party should consult the county surveyor, who can usually furnish this datum. When a large area is being surveyed it is especially desirable to do this, as the declination may vary considerably between the eastern and western parts of the survey. True north should be shown on the margin of all maps.

Odometer.—The Bell odometer has been adopted for use in all measurements. The instrument should be clamped to the axle of the vehicle and the iron pin driven in the end of the hub and bent so that as the wheel revolves the end of the pin just strikes the swell of the cogwheel on the odometer. The red hand revolves once every mile, giving the fractions of a mile, each space representing one-fortieth of a mile, or 8 rods. Each revolution of the red hand moves the yellow hand one space, representing the miles up to 40 in one revolution around the dial, and shown by the inside figures. Each revolution of the yellow hand moves the black hand one space, each space representing 40 miles, and shown by the outside figures. The sum of the indications of the three hands gives the mileage. Each odometer is adapted to but one sized wheel. In case it is impossible to obtain a vehicle with a wheel of the proper size for the odometer in use the readings must be corrected in order to read miles. Should any other sized wheel be used the following formula will enable the proper correction to be made:

$$x=\frac{ad}{d_1}$$

Where x is distance traversed in fortieths of a mile, d is the diameter of the wheel to be used, d_1 is the diameter of wheel to which the odometer is adapted, and a is number of dial divisions as read from odometer.

The instruments furnished by this Bureau are nearly all adapted to a 42-inch wheel. The following table will enable the proper correction to be made when any other than a 42-inch wheel is used. The figures in the first column are the dial divisions as read from the odometer, and the figures in the other columns give the distance traveled in fortieths of a mile. Chain scales divided into forty parts to an inch are supplied for convenience in platting distances as measured or calculated in this table.

Table for reducing odometer readings to fortieths of a mile.

Dial divisions.	Chain scale divisions for wheels of different diameters—inches.								
	36	**37**	**38**	**39**	**40**	**41**	**43**	**44**	**45**
1	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1
2	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.1
3	2.6	2.6	2.7	2.8	2.9	2.9	3.1	3.1	3.2
4	3.4	3.5	3.6	3.7	3.8	3.9	4.1	4.2	4.3
5	4.3	4.4	4.5	4.6	4.8	4.9	5.1	5.2	5.4
6	5.1	5.3	5.4	5.6	5.7	5.9	6.1	6.3	6.4
7	6.0	6.2	6.3	6.5	6.7	6.8	7.1	7.3	7.5
8	6.9	7.0	7.2	7.4	7.6	7.8	8.2	8.4	8.6
9	7.7	7.9	8.1	8.4	8.6	8.8	9.2	9.4	9.6
10	8.6	8.8	9.0	9.3	9.5	9.8	10.2	10.5	10.7
11	9.4	9.7	9.9	10.2	10.5	10.7	11.3	11.5	11.8
12	10.3	10.6	10.8	11.1	11.4	11.7	12.3	12.6	12.8
13	11.1	11.5	11.7	12.1	12.4	12.7	13.3	13.6	13.9
14	12.0	12.3	12.6	13.0	13.3	13.7	14.3	14.7	15.0
15	12.9	13.2	13.5	13.9	14.3	14.6	15.3	15.7	16.1
16	13.7	14.1	14.4	14.8	15.2	15.6	16.4	16.8	17.1
17	14.6	14.8	15.3	15.8	16.2	16.6	17.4	17.8	18.2
18	15.4	15.9	16.3	16.7	17.1	17.6	18.4	18.8	19.3
19	16.3	16.7	17.2	17.6	18.1	18.5	19.4	19.9	20.3
20	17.1	17.6	18.1	18.6	19.1	19.5	20.5	20.9	21.4
21	18.0	18.5	19.0	19.5	20.0	20.5	21.5	22.0	22.5
22	19.0	19.4	19.9	20.4	20.9	21.4	22.5	23.0	23.5
23	19.7	20.3	20.8	21.3	21.9	22.4	23.5	24.1	24.6
24	20.6	21.1	21.7	22.3	22.8	23.4	24.5	25.1	25.7
25	21.4	22.0	22.6	23.2	23.8	24.4	25.6	26.2	26.8
26	22.3	22.9	23.5	24.1	24.7	25.4	26.6	27.2	27.8
27	23.1	23.8	24.4	25.1	25.7	26.4	27.6	28.3	28.9
28	24.0	24.7	25.3	26.0	26.6	27.3	28.6	29.3	30.0
29	24.9	25.5	26.2	26.9	27.6	28.3	29.7	30.4	31.1
30	25.7	26.4	27.1	27.8	28.6	29.3	30.7	31.4	32.1
31	26.6	27.3	28.0	28.8	29.5	30.3	31.7	32.5	32.2
32	27.4	28.2	28.9	29.7	30.4	31.2	32.7	33.5	34.3
33	28.3	29.1	29.8	30.6	31.4	32.2	33.8	34.6	35.3
34	29.1	29.9	30.7	31.6	32.4	33.2	34.8	35.6	36.4
35	30.0	30.8	31.6	32.5	33.3	34.2	35.8	36.6	37.5
36	30.9	31.7	32.5	33.4	34.3	35.1	36.8	37.7	38.6
37	31.7	32.6	33.4	34.3	35.2	36.1	37.9	38.7	39.6
38	32.6	33.5	34.4	35.3	36.2	37.1	38.9	39.8	40.7
39	33.4	34.4	35.3	36.2	37.1	38.1	39.9	40.8	41.8
40	34.3	35.2	36.2	37.1	38.1	39.0	40.9	41.9	42.8
41	35.1	36.1	37.1	38.0	39.0	40.0	41.9	42.9	43.9
42	36.0	37.0	38.0	39.0	40.0	41.0	43.0	44.0	45.0
43	36.9	37.9	38.9	39.9	40.9	42.0	44.0	45.0	46.1
44	37.7	38.8	39.8	40.8	41.9	42.9	45.0	46.1	47.1
45	38.6	39.7	40.7	41.8	42.8	43.9	46.0	47.1	48.2

Field and office maps.—As soon as a section as large as 35 or 40 square miles has been surveyed, a copy or tracing of the map already finished, with soil legend attached, should be made and forwarded to the office, so that any accident which might happen to the original sheet would not destroy all record of the work. The sheets from which the map for publication are to be drawn should be marked "correct." This "correct" map may be either the office copy or the field sheets, and care should be taken to see that all sheets join up, so that the work will be complete when assembled.

Upon the completion of an area all maps, with complete legend and profile, all notebooks, plane-table sheets, and all other data collected during the survey, are to be forwarded to the Bureau.

Abbreviations.—In order to secure greater simplicity and uniformity on the field maps, the abbreviations of the principal words used in describing the texture of soils are given below. These abbreviations have been formed by taking the first letter, or in some cases the first two letters, of the word, as S. for sand and Si. for silt. When it is necessary to use more than one word to express the texture, the abbreviation for each word in the description should be given in the same order as the words: For example, the abbreviation for fine sandy loam should be written Fsl.; for sandy clay Sc.; for stony sandy loam Stsl., etc.

Stone	St.	Clay	C.	Hardpan	Hp.
Gravel	Gr.	Peat	P.	Light	Li.
Sand	S.	Muck	Mu.	Heavy	H.
Loam	L.	Adobe	A.		
Silt	Si.	Shale	Sh.		

Determining soil types.—The soil type is the unit of soil classification. A type comprises all soil material in any region which is marked to corresponding depths by identity or close similarity in texture, structure, organic matter content, and color, and by similarity of origin and of topography. A type comprises all soil material which may properly be included in one general description covering these points. In the humid regions the description covers the material to an average depth of 3 feet; in the arid regions to a depth of 6 feet. The average depth of the surface soil and its relationship to the subsoil should be included in the general description. If the material changes, either in the surface soil or in the subsoil, enough to affect definitely plant growth, the character of this change should be noted, and if the soil material in which it occurs is of sufficient extent it should be classed as a separate type.

When minor differences of texture, structure, organic matter content, or succession of materials occur in the soil sections representing single areas of 10 acres or more, such variations may be described in the report as phases. Such phase descriptions should always be subordinated to the description of the type of which they form variations.

While it is not desirable to make more types than is absolutely necessary, still every distinct type should be recognized, described, and mapped. There will, of course, be some local variation in the type, and where there is serious doubt as to the advisability of separating the soil material into two types the separation should be made, as doubtful types can be more easily combined than separated without further field work.

While agricultural value should be considered in the mapping of soils, it can not always be used as a safe guide in separating the soil into different types. Marked differences in the appearance and productiveness of the same type of soil have been observed in different areas, due not to any inherent difference in the character of the soil but to the employment of better and more thorough methods of cultivation on some parts than on others. Where these differences can be eliminated by the employment of similar methods of treatment, the soils should be mapped as the same type, although their present yields are very different.

Outlining soil boundaries.—Make preliminary borings in sufficient number to outline the location of a considerable body of soil material of uniform character. Record the general description of one or more borings. Select a color to represent this description and color in so much of the map as undoubtedly corresponds with the description. Work away from this identified area until soil materials are found which manifestly do not fit the former description. Select a second color for this new set of soil characteristics and color in on the map only where the new material undoubtedly occurs. Work in between the areas of the two types thus established until a zone or line is found where all material on one side becomes increasingly characteristic of the one type and on the other side of the other type. Draw a line on the map to represent this line or to represent the center of the zone of gradation of soil characteristics. This line will constitute a soil boundary. It is well to remember that, in mapping on a scale of 1 inch to 1 mile, an ordinary pencil or pen line one one-hundredth of an inch wide on the paper represents a width of nearly 53 feet on the ground. Soil variations occurring in areas smaller than 10 acres can not usually be represented, since a square on the map one-eighth of an inch on each side represents 10 acres on the ground, and smaller areas can not well be printed from engraved stones.

Naming soil types.—The type names employed by this Bureau consist of two essential parts: First, the descriptive or class name, such as sand, loam, or clay; second, a series or locality name, such as Miami, Marshall, or Norfolk. The descriptive part is to distinguish between soils of different classes or texture, while the series or locality part is used to distinguish between soils of the same class or texture, but differing materially with respect to origin, structure, organic-matter content, essential coloring, or other important characteristics.

The type name covers the entire profile. Where there occurs, as a subsoil, material which if exposed at the surface would be called Fresno sand, for instance, it is not proper to speak of this subsoil as Fresno sand, but as material which gives rise to the Fresno sand when exposed at the surface. Wherever the soil section is essentially modified by the presence of material of a different texture, so as to lose its identity, another soil type should be established. Thus, a section which showed from 6 to 15 inches of silt underlain by sand would be classed as a distinct type, although the underlying sand might be identical with the material of some other sandy type.

In this book is given a concise description of all the types of soil recognized by this Bureau up to December 31, 1905. In establishing types in each area this list should be carefully consulted. The field men will be held accountable for the recognition of all well-established soil types and for all possible correlations of soils in their areas with types already established. Provisional names should only be used in case of serious doubt or in the case of types which are known to be new. As soon as a thorough acquaintance with the type conditions has been obtained, a description of so general a nature that it will apply to the entire type should be sent in on Form 46. This type description should be made of every soil found in the area, whether it is correlated with a soil occurring in another area, or is recognized as a new type.

Wherever a type is encountered the identity of which is uncertain, the best possible suggestions should be made as to its correlation and a provisional name given it pending the determination of the exact place which the type occupies in the soil classification, and this name should be used in all subsequent correspondence in regard to the area. If for any reason the type name is changed after a sample has been sent in, the old name should be given in parentheses on label and card after the new or substituted name.

A soil, to be correlated with a type, must conform to it in certain broad, general features, but may differ from it in some details which do not greatly affect the crop value. The descriptions of the soil types given in this publication must be taken as the definition of the general average of the type; and it must be remembered that certain minor variations, such as are frequently called phases, may occur in different areas.

In the selection of local names for new or doubtful types the series relationship should be expressed in so far as it is known to exist. For example, soils found in a river bottom which differ only in texture should be classed in the same series. The same local name should not be employed for soils of different texture when no series relationship exists between them.

Samples for laboratory examination.—To avoid unnecessary work and to prevent overcrowding of the laboratory force, it will be necessary to use care and judgment in the selection of samples for mechanical or chemical examination.

As soon as a thorough acquaintance with the type conditions has been obtained, one preliminary sample of each doubtful type should be sent in for mechanical analyses, using the red tag for this and no other purpose, as an aid in determining the proper classification and correlation of the type. The analyses of these preliminary samples will be included in the report, together with those of samples collected later.

After the work has progressed sufficiently to insure a thoroughly representative set, a limited number of samples from not exceeding three places (including the preliminary samples) in each important soil type, and limited to one or two localities in the case of less important types, should be collected. The individual samples should be described on Form 47, one card being used for each sample, whether of a surface soil or a subsoil, and each sample should be designated by the name adopted for the type. This card (Form 47) should be sent in at the same time as the sample. Where the subsoil consists of two or more layers of entirely different texture, a separate sample of each layer should be taken. The samples should be taken, as far as practicable, when the soil is in good physical condition. When heavy clay soils are sent in a wet condition the samples dry into hard lumps, which can be crushed only with great difficulty.

In the correlation of the soils much importance is given to the samples, and great care is enjoined upon those in charge of parties to see that the samples are representative in every respect. The samples should be taken to represent the type as defined, and not with a view of showing all the different phases. Samples should not be located by towns outside of the area being surveyed. As it is sometimes desirable to know the exact location where a sample was taken, the location should be indicated on the field copy of the map by a small "s."

A separate card (Form 48) is provided for miscellaneous samples, such as marl, minerals, crusts, and plants, and in all cases such samples should be fully described, and the kind and purpose of the examination desired should be clearly stated. Often a qualitative examination will answer if the purpose of the work is known, and thus the long and tedious process of a complete chemical analysis may be avoided.

Care in attending to these details will insure the greatest accuracy and the earliest completion of the work, so that the results may be available as soon as possible, preferably before the party leaves the district.

Write all cards and tags on samples of soil in ink, as pencil rubs badly and is sometimes illegible when received in the office.

CLASSIFICATION OF SOILS.

While the classification of the soils within a given area must necessarily be determined in the field by the men who are actually engaged in the mapping of the area, the broader relationships between the soils of different areas must be taken up at the Bureau, where all of the information concerning the various areas is available and where the decision must be made as to what constitutes the general average of the type. The determination of the true relationships of the soils of different areas is a very difficult problem, and it is essential that the field men give all possible assistance in this work. In order that they may be in a position to render the best assistance in the solution of this problem, an outline of the general plan of classification, with a brief discussion of the principles upon which this arrangement is made, is given.

Soil type.—The fundamental unit in mapping and classifying soils is the type. In the determination of a type of soil there are many factors to be considered. Among the most important are the texture, which deals with the size of the particles, the structure, which deals with the arrangement, the organic-matter content, origin, color, depth, drainage, topography, native vegetation, and natural productiveness. The classification is based primarily upon the physical properties, but all factors that influence the relation of soils to crops, so far as their influence can be determined, are taken into consideration. Many of the soil types in a given locality have been formed by the same general processes, and they will necessarily grade one into another in respect to all characteristics.

Soil class.—Soil types, which constitute the units of soil classification, may be grouped in different ways. As soils are made up of particles of different sizes, they may be grouped according to the relative proportions of the particles of different sizes which they contain. This grouping is known as the *soil class*, and is based on texture. By means of mechanical analyses the particles less than 2 millimeters in diameter are separated into 7 grades and the various percentage relationships of the different grades determine the class of soil; that is, they determine whether it is a sand, sandy loam, loam, clay, or some intermediate class. In addition to the fine earth, of which a mechanical analysis is made, many soils contain larger particles, which if of small size are called "gravel," and if of larger size are called "stones," so that in the soil classification it is possible to have a gravelly sand, loam, or clay, and likewise stony members of the various classes.

As the soils of different classes grade into each other, the line of separation between the different classes is necessarily an arbitrary one. The particles also may be very irregularly distributed between the different grades, so that it is not possible to make a rigid classification according to the mechanical analyses. Much has been done, however, to systematize and bring into uniformity the classification by a careful examination of the analysis of several thousand samples, which have been described by the field men and analyzed in the laboratory of the Bureau. The following table shows the results of such an examination, and is intended as a guide in standardizing descriptions and as an aid in solving doubts concerning the proper classification of soils in new areas. Uniformity and close adherence to the standard are the chief considerations which it is desired to secure. The following table constitutes merely a codification and arrangement of facts reported by the field men. It has been found convenient to number the different grades into which the soil is separated by mechanical analysis. The name of the grade to which these numbers refer is given in the table.

Scheme of soil classification, based upon the mechanical composition of soils.

Class.	1. Fine gravel. 2–1 *mm.*	2. Coarse sand. 1–.5 *mm.*	3. Medium sand. .5–.25 *mm.*	4. Fine sand. .25–.1 *mm.*	5. Very fine sand. .1–.05 *mm.*	6. Silt. .05–.005 *mm.*	7. Clay. .005–0 *mm.*
Coarse sand.	More than 25 per cent of 1+2.					0–15	0–10
	More than 50 per cent of 1+2+3.					Less than 20 per cent of 6+7.	
Medium sand.	Less than 25 per cent of 1+2.					0–15	0–10
	More than 20 per cent of 1+2+3.					Less than 20 per cent of 6+7.	
Fine sand.	Less than 20 per cent of 1+2+3.					0–15	0–10
						Less than 20 per cent of 6+7.	
Sandy loam.	More than 20 per cent of 1+2+3.					10–35	5–15
						More than 20 per cent and less than 50 per cent of 6+7.	
Fine sandy loam.	Less than 20 per cent of 1+2+3.					10–35	5–15
						More than 20 per cent and less than 50 per cent of 6+7.	

Scheme of soil classification, based upon the mechanical composition of soils—Continued.

Class.	1. Fine gravel. 2-1	2. Coarse sand. 1-.5	3. Medium sand. .5-.25	4. Fine sand. .25-.1	5. Very fine sand. .1-.05	6. Silt. .05-.005	7. Clay. .005-0
Loam.							15-25
						Less than 55 per cent of 6.	
						More than 50 per cent of 6+7.	
Silt loam.						More than 55 per cent of 6.	Less than 25 per cent of 7.
Clay loam.						25-55	25-35
						More than 60 per cent of 6+7.	
Sandy clay.						Less than 25 per cent of 6.	More than 20 per cent of 7.
						Less than 60 per cent of 6+7.	
Silt clay.						More than 55 per cent of 6.	25-35 per cent of 7.
Clay.							More than 35 per cent of 7.
						More than 60 per cent of 6+7.	

Soil series.—It has been found that in many parts of the United States a given set of soil classes are so evidently related through source of material, method of formation, topographic position, and coloration that the different types constitute merely a gradation in the texture of an otherwise uniform material. Soils of different classes that are thus related constitute a series. A complete soil series consists of material similar in many other characteristics, but grading in texture from stones and gravel on the one hand, through the sands and loams, to a heavy clay on the other.

In arranging the soils in series the same factors should be considered that are used in separating soils of the same class into different types. For example, the Marshall silt loam and the Miami silt loam have been separated because of the difference in the amount and condition of the organic matter in the surface soil and the essential differences in coloration. The former is dark brown to black, while the latter is light brown to almost white. This same relation has been found to exist between soils of other classes in the glacial regions, and these factors have been used as a basis for separating the glacial soils into the Marshall and the Miami series. On account of the very different processes of their formation, residual and recent alluvial soils should not be included in the same series.

Soils may, however, be very similar in origin and texture but may occupy so entirely different topographic positions that their relation to crops is entirely changed, and this fact should be recognized by the use of another serial name. An example of this is found in the separation of the soils of the Piedmont Plateau and the Appalachian Mountains into the Cecil and the Porters series.

The color of the soil is one of its most noticeable physical features, and is often of the greatest assistance in separating the soils into different series. The soils of the Orangeburg series, for example, have been formed in a very similar manner to those of the Norfolk series, but are distinguished from the latter by the red color of the subsoil and the associated differences in agricultural value.

Soil series may grade into each other in a manner similar to the intergradation of the types within a series. Thus the Marshall series may grade into the Miami series and the Norfolk series into the Orangeburg or Portsmouth series.

Much advance has been made in the last two years in the arrangement of the soils in series. Several of the original types have been merged into others, or have been given new names in order to bring them into a uniform series, where this could be done without danger of confusion. If the field men acquaint themselves with the general characteristics of these series they will find it a great aid in placing soils of new areas. Furthermore, if any type in a series is thoroughly understood, the remaining types can be called to mind without reference to the printed description, thereby reducing the number of type descriptions necessary to be carried in the head. There will be found in nearly all areas soils of local origin and of exceptional character which will have to be given local names, but so far as possible the soils encountered in new areas should be correlated with established types, preference being given where possible to some of the great series described hereafter.

The following series have been established:

Soils of the Atlantic and Gulf Coastal Plains.

Norfolk series.—Light-colored soils with *yellow* sand or sandy clay subsoils.

Portsmouth series.—*Dark*-colored soils with yellow or mottled gray sand or sandy clay subsoils.

Orangeburg series.—Light-colored soils with *red* sandy clay subsoils.

Galveston series.—The coastal beaches and marshes.

Houston series.—Dark-gray or black calcareous prairies.

Lufkin series.—Light-colored soils with heavy mottled gray and yellow subsoils.

Gadsden series.—Gray soils with subsoils of similar texture occupying gentle slopes and depressions and formed by wash or creep from higher areas.

Susquehanna series.—Gray soils with heavy red clay subsoils which become mottled and variegated in color in the deep subsoil.

Wickham series.—Reddish or reddish-brown terrace soils overlying reddish, micaceous heavy sandy loam or loam subsoils.

Soils of the Flood Plains of the Mississippi and Other Rivers.

Wabash series.—*Dark-brown* or *black* alluvial soils subject to overflow.

Waverly series.—*Light*-colored alluvial soils subject to overflow.

Miller series.—*Brown* to *red* alluvial soils formed from the reworking of the Permian Red Beds.

Soils of the Piedmont Plateau.

Cecil series.—Gray to red soils with bright-red clay subsoils, derived from igneous and metamorphic rocks.

Penn series.—Dark Indian-red soils with red subsoils derived from red sandstones and shales of Triassic age.

Chester series.—Gray to brown surface soils with yellow subsoils, derived principally from schists and gneisses.

Soils of the Appalachian Mountains and Allegheny Plateaus.

Porters series.—Gray to red soils with red clay subsoils, derived from igneous and metamorphic rocks.

Dekalb series.—Brown to yellow soils with *yellow* subsoils, derived from sandstones and shales.

Upshur series.—Brown to red soils with *red* subsoils, derived from sandstones and shales.

Soils of the Limestone Valleys and Uplands.

Hagerstown series.—Brown to yellowish soils with yellow to reddish subsoils, derived from massive limestone.

Clarksville series.—Light-gray to brown soils with yellow to red subsoils, derived mainly from the St. Louis limestone.

Soils of the Glacial and Loessial Regions.

Miami series.—*Light*-colored upland timbered soils.

Marshall series.—*Dark*-colored upland prairie soils.

Volusia series.—Light-colored soils with yellowish subsoils, derived by feeble glacial action from sandstones and shales.

Soils of the Glacial Terraces.

Dunkirk series.—*Light*-colored reworked glacial material occurring as terraces around lakes and along streams.

Clyde series.—*Dark*-colored soils formed from reworked glacial material deposited in glacial lakes.

Sioux series.—Dark-colored soils resting on dark or light-colored subsoils with gravel beds usually within 3 feet of the surface.

Superior series.—Gray and red soils with *red* subsoils, formed from reworked glacial material deposited in glacial lakes.

Vergennes series.—Light-colored soils with gray or whitish subsoils, derived from Champlain clays or lighter deposits over these clays.

Residual Soils of the Western Prairie Regions.

Oswego series.—Gray or brown soils, derived from sandstones and shales.

Crawford series.—Brown soils with reddish subsoils, derived from limestones.

Vernon series.—Brown to red soils typical of the Permian formation.

Soils of the Great Basin.

Bingham series.—Porous dark or drab colluvial and alluvial soils underlain by gravel or rock, occupying lower mountain slopes.

Redfield series.—Red soils consisting of colluvial and alluvial materials derived from red sandstones and other rocks.

Malade series.—Dark-colored alluvial soils underlain by light-colored sands, sandy loams, or heavy reddish material.

Jordan series.—Light to dark-colored lacustrine deposits.

Salt Lake series.—Dark-colored soils underlain by stratified sediments of lacustrine origin.

Soils of the Northwestern Intermountain Regions.

Bridger series.—Dark-colored soils with sticky yellow subsoils, of colluvial and alluvial origin.

Yakima series.—Ash-gray to light-brown soils derived principally from ancient lake sediments consisting of an admixture of volcanic dust, basaltic, andesitic, and granitic materials.

Gallatin series.—Light to dark-colored soils with yellowish to dark compact subsoils, of recent alluvial origin from basaltic and volcanic rocks.

Soils of the Rocky Mountain Valleys, Plateaus, and Plains.

Laramie series.—Dark-colored soils with light-colored gravelly subsoils, derived from colluvial mountain wash.

Colorado series.—Light-gray to reddish-brown soils and subsoils, derived from colluvial wash.

Billings series.—Compact adobelike gray to dark or brown soils and subsoils, formed mainly by reworking of sandstones and shales and occupying old elevated stream terraces.

Fruita series.—Reddish-brown soils formed by reworking of sandstones and shales, occurring as stream terraces.

Mesa series.—Light-gray to brown soils derived from old flood-plain deposits now elevated to form mesa lands.

San Luis series.—Reddish-brown gravelly soils formed from lacustrine sediments of volcanic rocks.

Laurel series.—Light-gray to black soils underlain by river sands or gravels, occurring in flood plains along streams.

Soils of the Arid Southwest.

Indio series.—Light-colored soils usually underlain by coarser sands and gravels, formed by colluvial and alluvial wash from granitic rocks, mingled with some shale and sandstone.

Gila series.—Light to dark-brown soils of flood-plain alluvium, underlain at varying depths by coarse sands and gravels.

Imperial series.—Light-colored or reddish soils formed from old marine or lacustrine sediments modified by more recent deposits and underlain to great depths by heavy material.

Soils of the Pacific Coast.

Sierra series.—Light-gray to red and frequently gravelly soils, often underlain by red adobes.

Maricopa series.—Loose, dark-colored soils derived from unassorted colluvial or partially assorted alluvial materials, generally derived from granitic or volcanic rocks.

Placentia series.—Reddish soils derived largely from the weathering of alluvial and colluvial deposits, generally underlain by heavy compact red material with an impervious adobe structure.

Oxnard series.—Dark-colored alluvial or colluvial soils derived from higher lying areas of sandstones and shales.

San Joaquin series.—Compact red soils and subsoils derived from old marine sediments, usually underlain by red hardpan.

Stockton series.—Brown to black soils with heavy yellow subsoils, derived from old alluvial sediments.

Fresno series.—Light-colored soils with light-gray, ashy subsoils and alkali-carbonate hardpan, derived from old alluvial wash.

Hanford series.—Recent alluvium of flood or delta plains derived from a variety of rocks. The light-textured soils are light in color and the heavy-textured soils are dark in color.

Salem series.—Residual, alluvial, or colluvial soils, either red or dark in color, derived from rocks of basaltic, schistose, crystalline, or arenaceous character.

INSTRUCTIONS FOR ESTIMATING AND MAPPING ALKALI.

ELECTROLYTIC DETERMINATION OF TOTAL SALTS.

Principles of electrolytic determination.—The alkali content, in terms of total salts, is determined in both soils and waters by the use of the electrolytic bridge.[a]

By this instrument the electrical resistance in ohms, at 60° F., to the passage of a current through a cell filled with the soil or water in which the salt concentration is to be estimated, is determined. The resistance varies with the character and amount of the salts, decreasing as the concentration becomes greater. This rate of decrease in resistance with increase in concentration of any one particular salt or mixture of salts may be graphically represented by a curve. Such a curve, constructed experimentally by observing the resistance corresponding to various concentrations of a salt solution, will constitute a scale or standardization curve, from which the approximate concentration of salt solutions of the same general character may be determined from the resistance readings.

When for purposes of comparison and representation upon maps the alkali or salt content of soils is grouped into zones of various degrees of concentration, the resistance corresponding to the lines of separation or concentration limits will constitute a series of limiting values.

Instructions for operating the electrolytic bridge.—The irrigation water, or the soil, the electrical resistance of which is to be found, is put into the hard-rubber cell with metal electrodes. If the salt content of water is to be determined, the cell is filled even full with the water. If the salt content of soils is to be determined, the soil is placed in a shallow cup and thoroughly mixed or worked with distilled water until a condition of saturation is reached, indicated by the appearance of free water. The cell is then filled with this material, gently tapping the cell on the ground to exclude air bubbles. The top of the soil is then struck off with a knife edge, so that the cell shall be just level full of the saturated soil. The cell is then suspended in the mercury cups attached to the electrolytic bridge and the electrical resistance determined in the following way:

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[a] For a more complete description of the principles and operation of the electrolytic bridge, see Bulletins 8 and 15 and Circular 6, Division of Soils, U. S. Department of Agriculture.

The telephone receiver is pressed against the ear and the handle of the instrument pressed down, when a buzzing sound will be heard in the receiver. Holding the handle down so as to keep the battery switch closed, the pointer is rotated to either right or left until the position is found at which the note in the telephone receiver is no longer heard or is only indistinctly heard. On rotating the pointer to either side of this position, the sound in the receiver should gradually increase. In case difficulty is found in locating the exact position of balance, it will be found of assistance to rotate the pointer rapidly back and forth over the position of least sound, locating points of equal intensity on either side. The mean position between these two points gives the position of balance, and the number opposite the pointer gives the desired reading.

The sharpness of the minimum reading is much improved if the inner surfaces of the electrodes are kept clean and free from traces of grease. When waters are being tested, the cell should be occasionally cleaned with an alkaline solution or kept well scoured. The operator should avoid handling or touching the surfaces of the electrodes with the fingers.

In case a balance is not obtained with the 1,000-ohm coil of the rotary switch, the 100-ohm and 10-ohm coils should be tried in succession. It is best to choose the coil which will bring the balance as near as possible to the center of the scale, as this is the most sensitive position.

Having obtained the balance, the resistance is found by multiplying the resistance of the comparison coil, as shown by the rotating switch, by the number on the scale opposite the pointer. Thus, if the comparison coil used has a resistance of 100 ohms and the reading on the scale is 0.92, the resistance in the scale is 92 ohms. If the comparison coil is 1,000 ohms and the reading on the scale is 4.5, the resistance would be 4,500 ohms. After taking the resistance in this manner, take the temperature immediately, either of the water or of the saturated soil, by sticking the bulb of a thermometer in and leaving it for some moments. The resistance is then corrected for this temperature according to the directions given below.[a]

[a] In order to dislodge mercury from the expansion chamber at the top of the stem in the field thermometer, shake the mercury into the expansion chamber as far as possible and heat the chamber in boiling water or over the flame of a match.

Reduction of resistances to a temperature of 60° F.—A single illustration will serve to show the way the following table is used in the reduction of electrical resistances to a uniform temperature of 60° F.: Suppose the observed resistance of the soil is 2,585 ohms at a temperature of 50.5°. In the table, at the temperature of 50.5°, as indicated on the left-hand side, we find that at that temperature 2,000 ohms is equal to 1,748 ohms at 60°; 5,000 ohms is equal to 4,370 ohms at 60°; hence 500 ohms would be equal to 437 ohms. Similarly, 80 ohms would be one-hundredth of the value given for 8,000 ohms at 50.5° in the table, therefore equal to about 70 ohms at 60°, while the 5 ohms would be equal to about 4 ohms. These separate values are added together thus:

2,000	1,748
500	437
80	70
5	4
2,585 ohms at 50.5°	=2,259 ohms at 60°.

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.

°F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
32.0	625	1,250	1,875	2,500	3,125	3,750	4,375	5,000	5,625
32.5	632	1,264	1,896	2,528	3,150	3,792	4,424	5,056	5,688
33.0	639	1,278	1,917	2,556	3,195	3,834	4,473	5,112	5,751
33.5	646	1,292	1,938	2,584	3,230	3,876	4,522	5,168	5,814
34.0	653	1,306	1,959	2,612	3,265	3,918	4,571	5,224	5,877
34.5	660	1,320	1,980	2,640	3,300	3,960	4,620	5,280	5,940
35.0	667	1,334	2,001	2,668	3,335	4,002	4,669	5,336	6,003
35.5	674	1,348	2,022	2,696	3,370	4,044	4,718	5,392	6,066
36.0	681	1,362	2,043	2,724	3,405	4,086	4,767	5,448	6,129
36.5	688	1,376	2,064	2,752	3,440	4,128	4,816	5,504	6,192
37.0	695	1,390	2,085	2,780	3,475	4,170	4,865	5,560	6,255
37.5	702	1,404	2,106	2,808	3,510	4,212	4,914	5,616	6,318
38.0	709	1,418	2,127	2,836	3,545	4,254	4,963	5,672	6,381
38.5	716	1,432	2,148	2,864	3,580	4,296	5,012	5,728	6,444
39.0	722	1,444	2,166	2,888	3,610	4,332	5,054	5,776	6,498
39.5	729	1,458	2,187	2,916	3,645	4,374	5,103	5,832	6,561
40.0	736	1,472	2,208	2,944	3,680	4,416	5,152	5,888	6,634
40.5	743	1,486	2,229	2,972	3,715	4,458	5,201	5,944	6,687
41.0	750	1,500	2,250	3,000	3,750	4,500	5,250	6,000	6,750
41.5	757	1,514	2,271	3,028	3,785	4,542	5,299	6,056	6,813

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.—Continued.

° F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
42.0	763	1,526	2,289	3,052	3,815	4,578	5,341	6,104	6,867
42.5	770	1,540	2,310	3,080	3,850	4,620	5,390	6,160	6,930
43.0	776	1,552	2,328	3,104	3,880	4,656	5,432	6,208	6,984
43.5	782	1,564	2,346	3,128	3,910	4,692	5,474	6,256	7,038
44.0	788	1,576	2,364	3,152	3,940	4,728	5,516	6,304	7,092
44.5	794	1,588	2,382	3,176	3,970	4,764	5,558	6,352	7,146
45.0	800	1,600	2,400	3,200	4,000	4,800	5,600	6,400	7,200
45.5	807	1,614	2,421	3,228	4,035	4,842	5,649	6,456	7,263
46.0	814	1,628	2,442	3,256	4,070	4,884	5,698	6,512	7,326
46.5	821	1,642	2,463	3,284	4,105	4,926	5,747	6,568	7,389
47.0	828	1,656	2,484	3,312	4,140	4,968	5,796	6,624	7,452
47.5	835	1,670	2,505	3,340	4,175	5,010	5,845	6,680	7,515
48.0	842	1,684	2,526	3,368	4,210	5,052	5,884	6,736	7,578
48.5	849	1,698	2,547	3,396	4,245	5,094	5,933	6,792	7,641
49.0	856	1,712	2,568	3,424	4,280	5,136	5,992	6,848	7,704
49.5	862	1,724	2,586	3,448	4,310	5,172	6,034	6,896	7,758
50.0	868	1,736	2,604	3,472	4,340	5,208	6,076	6,944	7,812
50.5	875	1,750	2,625	3,500	4,375	5,250	6,125	7,000	7,875
51.0	881	1,762	2,643	3,524	4,405	5,286	6,167	7,048	7,929
51.5	887	1,774	2,661	3,548	4,435	5,322	6,209	7,096	7,983
52.0	893	1,786	2,679	3,572	4,465	5,358	6,251	7,144	8,037
52.5	900	1,800	2,700	3,600	4,500	5,400	6,300	7,200	8,100
53.0	906	1,812	2,718	3,624	4,530	5,436	6,342	7,248	8,154
53.5	912	1,824	2,736	3,648	4,560	5,472	6,384	7,296	8,208
54.0	919	1,838	2,757	3,676	4,595	5,514	6,433	7,352	8,271
54.5	926	1,852	2,778	3,704	4,630	5,556	6,482	7,408	8,334
55.0	933	1,866	2,799	3,732	4,665	5,598	6,531	7,464	8,397
55.5	940	1,880	2,820	3,760	4,700	5,640	6,580	7,526	8,460
56.0	947	1,894	2,841	3,780	4,735	5,682	6,629	7,576	8,523
56.5	954	1,908	2,862	3,816	4,770	5,724	6,678	7,632	8,586
57.0	961	1,922	2,883	3,844	4,805	5,766	6,727	7,688	8,649
57.5	968	1,936	2,904	3,872	4,839	5,807	6,775	7,743	8,711
58.0	974	1,948	2,922	3,896	4,870	5,844	6,818	7,792	8,766
58.5	981	1,962	2,943	3,924	4,905	5,886	6,867	7,848	8,829
59.0	987	1,974	2,962	3,949	4,936	5,923	6,910	7,898	8,885
59.5	994	1,988	2,982	3,976	4,971	5,965	6,959	7,953	8,947
60.0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000
60.5	1,006	2,012	3,018	4,024	5,030	6,036	7,042	8,048	9,054
61.0	1,013	2,026	3,039	4,052	5,065	6,078	7,091	8,104	9,117
61.5	1,020	2,040	3,060	4,080	5,100	6,120	7,140	8,160	9,180
62.0	1,027	2,054	3,081	4,108	5,135	6,162	7,189	8,216	9,243
62.5	1,033	2,066	3,099	4,132	5,165	6,198	7,231	8,264	9,297
63.0	1,040	2,080	3,120	4,160	5,200	6,240	7,280	8,320	9,360
63.5	1,047	2,094	3,141	4,188	5,235	6,282	7,329	8,376	9,423

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.—Continued.

° F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
64.0	1,054	2,108	3,162	4,216	5,270	6,324	7,378	8,432	9,486
64.5	1,061	2,122	3,183	4,244	5,305	6,366	7,427	8,488	9,549
65.0	1,068	2,136	3,204	4,272	5,340	6,408	7,476	8,544	9,612
65.5	1,075	2,150	3,225	4,300	5,375	6,450	7,525	8,600	9,675
66.0	1,082	2,164	3,246	4,328	5,410	6,492	7,574	8,656	9,738
66.5	1,089	2,178	3,267	4,356	5,445	6,534	7,623	8,712	9,801
67.0	1,096	2,192	3,288	4,384	5,480	6,576	7,672	8,768	9,864
67.5	1,103	2,206	3,309	4,412	5,515	6,618	7,721	8,824	9,927
68.0	1,110	2,220	3,330	4,440	5,550	6,660	7,770	8,880	9,990
68.5	1,117	2,234	3,351	4,468	5,585	6,702	7,819	8,936	10,053
69.0	1,125	2,250	3,375	4,500	5,625	6,750	7,875	9,000	10,125
69.5	1,133	2,266	3,399	4,532	5,665	6,798	7,931	9,064	10,197
70.0	1,140	2,280	3,420	4,560	5,700	6,840	7,980	9,120	10,260
70.5	1,147	2,294	3,441	4,588	5,735	6,882	8,029	9,176	10,323
71.0	1,155	2,310	3,465	4,620	5,775	6,930	8,085	9,240	10,395
71.5	1,162	2,324	3,486	4,648	5,810	6,972	8,134	9,296	10,458
72.0	1,170	2,340	3,510	4,680	5,850	7,028	8,190	9,360	10,530
72.5	1,177	2,354	3,531	4,708	5,885	7,062	8,239	9,416	10,593
73.0	1,185	2,370	3,555	4,740	5,925	7,110	8,295	9,480	10,665
73.5	1,193	2,386	3,579	4,772	5,965	7,158	8,351	9,544	10,737
74.0	1,201	2,402	3,603	4,804	6,005	7,206	8,407	9,608	10,809
74.5	1,208	2,416	3,624	4,832	6,040	7,248	8,456	9,664	10,872
75.0	1,215	2,430	3,645	4,860	6,075	7,290	8,505	9,720	10,935
75.5	1,222	2,444	3,666	4,888	6,110	7,332	8,554	9,776	10,998
76.0	1,230	2,460	3,690	4,920	6,158	7,380	8,610	9,840	11,070
76.5	1,238	2,476	3,714	4,952	6,190	7,428	8,666	9,904	11,142
77.0	1,246	2,492	3,738	4,984	6,230	7,476	8,722	9,968	11,214
77.5	1,254	2,508	3,762	5,016	6,270	7,524	8,778	10,032	11,286
78.0	1,262	2,524	3,786	5,048	6,310	7,572	8,834	10,096	11,358
78.5	1,270	2,540	3,810	5,080	6,350	7,620	8,890	10,160	11,430
79.0	1,278	2,556	3,834	5,112	6,390	7,668	8,946	10,224	11,502
79.5	1,286	2,572	3,858	5,144	6,430	7,716	9,002	10,288	11,574
80.0	1,294	2,588	3,882	5,176	6,470	7,754	9,058	10,352	11,646
80.5	1,302	2,604	3,906	5,208	6,510	7,812	9,114	10,416	11,718
81.0	1,310	2,620	3,930	5,240	6,550	7,860	9,170	10,480	11,790
81.5	1,318	2,636	3,954	5,272	6,590	7,908	9,226	10,544	11,862
82.0	1,327	2,654	3,981	5,308	6,635	7,962	9,289	10,616	11,943
82.5	1,335	2,670	4,005	5,340	6,675	8,010	9,345	10,680	12,015
83.0	1,343	2,686	4,029	5,372	6,715	8,058	9,401	10,744	12,087
83.5	1,351	2,702	4,053	5,404	6,755	8,106	9,457	10,808	12 159
84.0	1,359	2,718	4,077	5,436	6,795	8,154	9,513	10,872	12,231
84.5	1,367	2,734	4,101	5,468	6,835	8,202	9,569	10,936	12,303

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.—Continued.

° F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
85.0	1,376	2,752	4,128	5,504	6,880	8,256	9,632	11,008	12,384
85.5	1,385	2,770	4,155	5,540	6,925	8,310	9,695	11,080	12,465
86.0	1,393	2,786	4,179	5,572	6,965	8,358	9,751	11,144	12,537
86.5	1,401	2,802	4,203	5,604	7,005	8,406	9,807	11,208	12,609
87.0	1,409	2,818	4,227	5,636	7,045	8,454	9,863	11,272	12,681
87.5	1,418	2,836	4,254	5,672	7,090	8,508	9,931	11,344	12,762
88.0	1,427	2,854	4,281	5,708	7,135	8,562	9,989	11,416	12,843
88.5	1,435	2,870	4,305	5,740	7,175	8,610	10,040	11,480	12,915
89.0	1,443	2,886	4,329	5,772	7,215	8,658	10,091	11,544	12,987
89.5	1,451	2,902	4,353	5,804	7,255	8,706	10,157	11,608	13,059
90.0	1,460	2,920	4,380	5,840	7,300	8,760	10,220	11,680	13,140
90.5	1,468	2,936	4,404	5,872	7,340	8,808	10,276	11,744	13,212
91.0	1,477	2,954	4,431	5,908	7,385	8,862	10,339	11,816	13,293
91.5	1,486	2,972	4,458	5,944	7,430	8,916	10,402	11,888	13,374
92.0	1,495	2,990	4,485	5,980	7,475	8,970	10,465	11,960	13,455
92.5	1,504	3,008	4,512	6,016	7,520	9,024	10,528	12,032	13,536
93.0	1,513	3,026	4,539	6,052	7,565	9,078	10,591	12,104	13,617
93.5	1,522	3,044	4,566	6,088	7,610	9,132	10,654	12,176	13,698
94.0	1,531	3,062	4,593	6,124	7,655	9,186	10,717	12,248	13,779
94.5	1,540	3,080	4,620	6,160	7,700	9,240	10,780	12,320	13,860
95.0	1,549	3,098	4,647	6,196	7,745	9,294	10,843	12,392	13,941
95.5	1,559	3,118	4,677	6,236	7,795	9,354	10,913	12,472	14,031
96.0	1,569	3,138	4,707	6,276	7,845	9,414	10,983	12,552	14,121
96.5	1,579	3,158	4,737	6,316	7,895	9,474	11,053	12,632	14,211
97.0	1,589	3,178	4,767	6,356	7,945	9,534	11,123	12,712	14,301
97.5	1,599	3,198	4,797	6,396	7,995	9,594	11,193	12,792	14,391
98.0	1,609	3,218	4,827	6,436	8,045	9,654	11,263	12,872	14,481
98.5	1,619	3,238	4,857	6,476	8,095	9,714	11,333	12,952	14,571
99.0	1,629	3,258	4,887	6,516	8,145	9,774	11,403	13,032	14,661

Concentration intervals.—The concentration limits used in the classification of alkali soils are, respectively, 0.20, 0.40, 0.60, 1, and 3 per cent of total salts in the dry soil, the maps showing the distribution of the several grades of concentration being constructed in the field directly from field determinations.

Average standardization.—In the alkali surveys carried on by the Bureau standardization curves have been constructed in many widely separated areas differing greatly in the character of the salts present. From the average of 15 such curves an average standardization curve has been obtained, from which the following table of limiting values or electrical resistances, corresponding to the various degrees of concentration, are derived.

These values are found of sufficient accuracy to warrant their use in all reconnoissance work, and can be used in alkali surveys involving approximate determinations over limited areas, or in all alkali surveys where subject to check by independent standardization. In case it is found that the average curve does not give reliable results, or where unusual accuracy is required, a new curve should be made according to the instructions given on page 31.

Average standardization—Table of limiting values.

Salt in soil.	Sand and sandy loam.	Loam.	Clay loam.	Clay.	Average.
Per cent.	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*
3.00	21.9	24.9	26.7	27.4	25.2
1.00	43.7	45.3	47.7	48.8	46.4
.60	65.9	68.8	71.1	73.5	69.8
.40	92.1	95.3	98.7	101.4	96.9
.20	163.6	172.5	178.7	193.4	177.1

For convenience, where it is desired to determine the percentage of alkali from the resistance at 60° F., the following table has been picked out from the average standardizations:

Table showing percentage of salt in soil.

Resistance at 60° F.	Sand and sandy loam.	Loam.	Clay loam.	Clay.
	Per cent salt.	*Per cent salt.*	*Per cent salt.*	*Per cent salt.*
20	3.12	....	....	....
25	2.65	2.98	3.19	3.30
30	2.18	2.43	2.65	2.79
35	1.69	1.91	2.13	2.28
40	1.18	1.40	1.63	1.77
45	.95	1.02	1.18	1.28
50	.83	.89	.94	.97
55	.74	.80	.84	.87
60	.67	.71	.74	.78
65	.60	.64	.67	.71
70	.55	.58	.61	.65
75	.51	.54	.56	.59
80	.47	.51	.52	.54
85	.44	.47	.49	.50
90	.41	.43	.45	.47
95	.38	.40	.42	.44
100	.36	.37	.39	.41
105	.34	.35	.37	.38
110	.32	.33	.35	.36
115	.30	.31	.33	.34
120	.29	.30	.31	.33
125	.27	.28	.30	.31
130	.25	.27	.28	.30
135	.24	.26	.27	.29
140	.23	.25	.26	.28
145	.22	.24	.25	.26
150	.21	.23	.24	.25
155	.21	.22	.23	.24
160	.20	.21	.22	.23
165	.20	.21	.22	.23
170	.19	.20	.21	.22

Directions for making standardizations.—If greater accuracy be desired, or if it be believed that the average standardization curve is not applicable to the conditions, a standardization curve or table is to be constructed in each district, by the following methods, reducing all resistances to the basis of 60° F. by use of the preceding tables:

Take 8 or 10 crusts, including the top inch of soil, or if crusts can not be obtained, use the strongest alkali soils collected from different places over the whole area. Place a portion of each of the several crusts or soils in a large cup or bottle, filling the vessel from one-fourth to one-half full, according to the concentration of the material, using the greater quantity where the material is less concentrated. Nearly fill the vessel with distilled water, stirring or shaking frequently, and with the filter pump filter off a portion of each solution, cleaning the pump and filter tube and discarding the first 50 c. c. of subsequent filtrate after each filtration. Discoloration of solutions from the presence of black alkali may be ignored.

Determine the electrical resistance of each solution, and either dilute with distilled water or else increase the concentration by evaporation or the addition of more alkali material until each filtrate shows a resistance of approximately 10 ohms at 60° F. From equal volumes taken from each solution make up in a large vessel a composite solution not less than 1 quart in volume. From 100 c. c. of this composite solution determine the weight in grams[a] of soluble salts by evaporation, igniting gently before weighing. Divide the weight so obtained into each percentage given in the last four columns of the following table and multiply the quotient by 100. The result in each case represents the number of cubic centimeters of composite solution to be diluted with distilled water to 100 c. c. in order to obtain the corresponding percentage of salt in soil given in the first column of the table. If the volume thus secured for some of the higher concentrations exceeds 100 c. c., it should be reduced to 100 c. c. by evaporation. Ordinarily a 3.33 per cent solution is as concentrated as will be required, as this represents 1 per cent of salt in the soil. (See note below.)

To obtain limiting values.

Salt in soil.	Salt in solution.			
	Sand and sandy loam.	Loam.	Clay loam.	Clay.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3.00	10.00	7.95	7.14	6.67
1.00	3.33	2.65	2.38	2.22
.60	2.00	1.59	1.43	1.33
.40	1.33	1.06	.95	.89
.20	.67	.53	.48	.44
Resistances to be reduced to 60° F. and divided by	.24	.275	.29	.30

The resistance in ohms of each dilution of the composite solution, divided by the factor appearing at the foot of the column designating

[a] Weighing, if done with care, may be upon druggist's scales, 15.5 grains equaling 1 gram.

the class of soil in the preceding table, will give for each class of soil the limiting value, or resistance in the cell at 60° F. of saturated soil corresponding to the concentration limits. These resistances or limiting values are to be inserted in the proper place in the following table:

Table of limiting values.

Salt in soil.	Sand and sandy loam.	Loam.	Clay loam.	Clay.
Per cent.	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*
3.00	....	....	....	....
1.00	....	....	....	....
.60	....	....	....	....
.40	....	....	....	....
.20	....	....	....	....

NOTE.—If it is desirable to determine the 3 per cent limit in the soil, portions of the composite solution will have to be concentrated by evaporation according to the above directions so as to contain the percentage of salt given in the table. The cell filled with such concentrated solutions gives a resistance too low to be read on the instrument, and it will be necessary to take a measured amount of the solution in the cell, as for example, one-fourth or one-fifth its capacity. Determine the resistance and divide it by 4 or 5, as the case may be. This gives the resistance of the cell when filled. For these concentrated solutions the readings will be rather indefinite. Keep the cell electrodes well cleaned at all times.

ALKALI MAPS.

Principles of alkali mapping.—In making alkali maps the soils are grouped according to certain arbitrary limits, the basis of separation being the average percentage of total salts in the dry soil to the depth of 6 feet. The injurious effects upon crops varies considerably in the case of different salts, but only in the case of sodium carbonate, or black alkali, is the difference so great as to require the use of other limits and the construction of a separate map.

The first grade of alkali soils includes areas where the content is less than 0.20 per cent in the case of total salts, and less than 0.05 per cent in the case of the more highly injurious black alkali. These limits were selected as representing the concentration of salts within which all ordinary crops grow without apparent injury. In cases where these contents for the 6-foot profile are accompanied by accumulations of much greater concentration upon the immediate surface, or at some other section in the soil profile, such concentration is shown by special rulings and legends explained later.

The second grade comprehends soil containing between 0.20 and 0.40 per cent of total salts, and in the case of sodium carbonate or black alkali 0.05 to 0.10 per cent of that salt. Soils of this grade fall within the first limits of danger, for while under favorable conditions the more hardy crops may escape injury, evidence of injury to the less tolerant plants, such as grains, young vegetables, beans, citrus, and many other fruits, is frequently observed. When accompanied by more highly concentrated accumulations at the surface, barren spots may occur in fields of alfalfa or other of the more tolerant crops.

The third grade includes areas where the total salt content ranges from 0.40 to 0.60 per cent, and where 0.10 to 0.20 per cent of black alkali is found. These concentrations are usually marked by the occurrence of a larger number of barren spots, by the appearance of alkali crusts and characteristic alkali vegetation, and by a consequent decrease in yield or a failure of crops.

In the following two grades the concentration of total salts ranges from 0.60 to 1 per cent and 1 to 3 per cent, respectively. On land of this character there is generally a failure of all but the most tolerant crops, and it is ultimately thrown out of cultivation.

The last grade in the classification covers soils showing more than 3 per cent of total salts—a condition seldom encountered except in the barren beds of desiccated salt lakes.

Similarly, the two higher grades of concentration of black alkali—0.20 to 0.30 per cent and more than 0.30 per cent, respectively—represent conditions prohibitive of ordinary crop production.

Careful observation of the character of prevailing soil types, topography, drainage features, character of native vegetation, and the condition of growing crops will aid greatly in locating boundaries defining the areas of the several grades of alkali soils.

Methods of sampling.—Sampling for alkali determinations is done with the ordinary soil auger, the soil being separated into foot sections and placed upon a small sheet of oilcloth or similar material of convenient size. Gravel and roots, or other extraneous matter, are removed by the hand and the soil prepared for electrolytic determination as previously described. The exact location of all borings made for alkali determinations, with brief descriptions of the texture and structure of the soil, the topography, drainage features, character of native vegetation, condition of crops, original resistance, cell temperature, and corrected resistance, should be entered in the Alkali Field Book.

Total-alkali maps.—The percentage of alkali salts in each sectional foot of soil to a depth of 6 feet will be determined according to the directions previously given in this publication and in the Alkali Field Book. In many cases, after the observer becomes familiar with the soils of a locality, the fieldwork may be very much shortened by making the alkali determinations in alternate foot sections or by mixing 2 or more feet for one salt determination.

The percentage of alkali, as indicated by the various colors upon the alkali map, is to be a mathematical average of the alkali in the foot sections. In case there should be a marked accumulation of the alkali at any one part of the vertical section, such as the surface of the ground or in an alkali hardpan, the judgment of the observer is to decide whether the strict mathematical average should be followed or whether the soil is to be mapped as of the next higher grade of alkali content. If these areas, where there is a zone of accumulation of the alkali, such as an accumulation at the surface, are of considerable extent, they are to be indicated upon the field map by special rulings in lead pencil, and when the field maps are published the rulings will be described in the legend of the map. Thus, if a soil contain on an average 0.20 per cent of alkali, but has an accumulation of 0.50 per cent of alkali on the surface, this soil should be colored to show 0.20 per cent alkali, and the fact that there is a surface accumulation should be indicated by black rulings across the area affected. If the accumulation is below the surface foot another kind of ruling can be used to indicate that fact. Appropriate lettering upon the maps will render these rulings intelligible.

Determination of carbonates, bicarbonates, and chlorides in soils.[a]—Fill the small brass cone found in the field outfit, or other vessel of known volume, with saturated soil as prepared for electrolytic determinations, wash into a 250 c. c. bottle or flask, fill to the mark with distilled water, shaking thoroughly, and then filter, discarding the first 50 c. c. of filtrate in order to eliminate errors from the introduction of previous solutions retained in the porous tube of the filter pump. Titrate 50 c. c. of the solution, representing one-fifth of the total volume of saturated soil, with N/20 acid potassium sulphate containing 6.811 grams per liter, using phenolphthalein as an indicator. This will represent the carbonates. Then add a drop or so of methyl orange or

[a] See Bulletins 18 and 31, Bureau of Soils, for more complete directions and discussion of this matter.

congo red and again titrate with N/20 acid potassium sulphate. Subtract an amount equal to the first titration from the second, and the difference represents the bicarbonates. Add a few drops of potassium chromate as an indicator to the same solution and titrate with N/10 silver nitrate. This will represent the chlorides. The salts are all to be estimated as sodium salts, as follows:

1 c. c. N/20 $HKSO_4$ is equivalent to 0.005305 gram Na_2CO_3.
1 c. c. N/20 $HKSO_4$ is equivalent to 0.004203 gram $NaHCO_3$.
1 c. c. N/10 $AgNO_3$ is equivalent to 0.00585 gram Na Cl.

Black alkali maps.—In areas where the amount and distribution of sodium carbonate warrant the construction of a black-alkali map, it is made in the field from the volume of N/20 acid potassium sulphate solution used in titration for carbonates in the surface foot of soil. The concentration limits are 0.05, 0.1, 0.2, and 0.3 per cent of sodium carbonate in the dry soil. The limiting values for each vessel are found in the following way: Multiply the volume of saturated soil, represented by the solution taken for titration, equal to one-fifth the total amount, by the numbers in the following table:

Na_2CO_3 in soil.	Sand and sandy loam.	Loam.	Clay loam.	Clay.
Per cent.				
0.30	0.832	0.752	0.720	0.689
.20	.554	.502	.480	.459
.10	.277	.251	.240	.230
.05	.138	.125	.120	.115

The results thus obtained are the number of cubic centimeters of N/20 acid potassium sulphate solution used in titrating the carbonates, corresponding to the concentration limits to be inserted in the following table:

Na_2CO_3 in soil.	Sand and sandy loam.	Loam.	Clay loam.	Clay.
Per cent.	*c. c.*	*c. c.*	*c. c.*	*c. c.*
0.30	....	....	....	....
.20	....	....	....	....
.10	....	....	....	....
.05	....	....	....	....

If it is desired to reduce the volume of $N/10$ $AgNO_3$ to per cent of NaCl in dry soil, the following formula may be used:

$$\frac{V\ 0.00585}{V'\ K}$$

Substituting 0.004203 for 0.00585, the same formula may be used to reduce the volume of $N/20$ $HKSO_4$ to per cent of $NaHCO_3$. V=cubic centimeters $N/10$ $AgNO_3$ or $N/20$ $HKSO_4$ solution used; V'=volume saturated soil represented in amount of solution titrated; K=constant for type of soil as follows: Sand and sandy loam=1.46; loam=1.32; clay loam=1.26; clay=1.21.

DETERMINATION OF TOTAL SALTS IN WATER.

The total salt content of irrigating, drainage, or other waters, in parts per 100,000, may be determined within a reasonable degree of accuracy from the following table, the resistance at 60° F. being ascertained according to the directions given in the preceding pages. The curve varies according to the character of the salts present. Where no carbonates are present in the water, the figures in the column marked "Chlorides" should be used. When preliminary examination by titration indicates that more than 50 per cent of the total salts is carbonates, the figures in the column marked "Carbonates" should be used. For intermediate percentages of carbonates, a corresponding intermediate value between those given in the two columns should be used.

Table for determining total salt content of water from resistance at 60° F.

Resistance 60° F.	Chlorides.	Carbonates.	Resistance 60° F.	Chlorides.	Carbonates.	Resistance 60° F.	Chlorides.	Carbonates.
	Pts. per 100,000.			*Pts. per 100,000.*			*Pts. per 100,000.*	
30	750		140	141	200	340	50	71
35	670		150	132	187	360	47	65
40	595		160	124	176	380	44	60
45	525		170	116	165	400	41	55
50	460	460	180	109	154	450	35	46
55	400	425	190	102	144	500	31	38
60	355	395	200	96	138	550	28	32
65	305	375	210	91	130	600	25	27
70	265	355	220	87	122	700	22	23
75	230	335	230	83	116	800	20	
80	213	320	240	79	110	900	19	
85	203	306	250	75	105	1,000	18	
90	195	294	260	71	100	1,200	17	
95	188	284	270	68	95	1,400	16	
100	181	262	280	65	90	1,600	16	
110	170	250	290	62	86	1,800	15	
120	160	231	300	59	83	2,000	15	
130	150	213	320	54	77			

The electrolytic cells are made as nearly of the same dimensions as possible, but if there is much variation in either volume or shape this table must not be used without a correction for the cell.

If greater accuracy is desired than can be expected by the use of the above table, proceed in the following way:

Collect 6 or 8 samples of water from different parts of the area, determine the electrical resistance of each, and take an amount of each proportional to the resistance, mixing them in a clean vessel. There should be at least 2 quarts, and preferably 1 gallon, of this mixture. Evaporate slowly on a stove until the mixture is about as strong as the strongest water likely to be encountered. If there is any possibility of encountering water as strong as a 1 per cent solution—that is, 1,000 parts of salts in 100,000 parts of water—the mixture should be evaporated until it gives a resistance in the cell of about 23 ohms. The amount of this evaporation can be determined by the original resistance of the mixture. If the resistance of the mixture is 100 ohms, it should be evaporated to one-fourth its volume to make approximately a 1 per cent solution. If the resistance is 400 ohms, the solution should be evaporated to one twenty-third of its original volume. Water having a resistance of 400 ohms would have a salt content, according to the above table, of about 44 in 100,000, and would be considered an excellent water for irrigation purposes. It would require 3 gallons of such water evaporated to 1 pint to make a 1 per cent solution.

Determine the percentage of salts in this solution by evaporation to dryness. If necessary, the weights may be determined by weighing on druggist's scales.

Take the concentrated solution and dilute with successive quantities of distilled water, so as to change the concentration of the solution and get the corresponding resistances in the cell. Use, for example, 9 parts of the solution and 1 part distilled water, then 8 parts of the solution and 2 parts of distilled water, and so on down to any dilution likely to be encountered. This will give the resistance corresponding very exactly with known amounts of salt, and will furnish a table for the estimation of the salt content from the resistance of any water in the area.

The table constructed from this data can be used directly by interpolation, or preferably a curve should be constructed and any intermediate points picked out from this.

Determination of carbonates, bicarbonates, and chlorides in water.—When water is examined by chemical methods, as described in the preceding pages, 50 c. c. of water should be used in making the titration. Calculation of results may readily be made from the following table:

C. c. N/20 $KHSO_4$ or N/20 $AgNO_3$.	Parts per 100,000 of water.		
	Na_2CO_3.	$NaHCO_3$.	NaCl.
1	10.53	8.34	11.61
2	21.06	16.69	23.22
3	31.60	25.03	34.84
4	42.13	33.38	46.45
5	52.66	41.72	58.06
6	63.19	50.06	69.67
7	73.72	58.41	81.28
8	84.26	66.75	92.89
9	94.79	75.10	104.51

INSTRUCTIONS FOR QUALITATIVE DETERMINATION OF ALKALI SALTS.

Should a further field examination of crusts, minerals, concretions, or other substances appear desirable as supplementary to the ordinary field tests, or as preliminary to laboratory analysis, the following simple methods may be used:

Calcium.—To about 25 c. c. of the filtered soil solution add a little concentrated hydrochloric acid, and then enough ammonia water to impart a perceptible ammoniacal odor. Should a precipitate be formed redissolve in hydrochloric acid and again make alkaline with ammonia water. Repeat the alternate addition of hydrochloric acid and ammonia water until no white precipitate is formed when the solution is alkaline with ammonia. Then add a few crystals of ammonium oxalate and heat to boiling. Allow to stand a few minutes. A white precipitate shows the presence of calcium. A slight turbidity indicates small amounts of calcium.

Magnesium.—Filter off the calcium precipitate on a small filter, cool the filtrate, and add a few crystals of sodium phosphate. Shake to dissolve the phosphate, then add ammonia water equal in amount to about one-third of the volume of the liquid, and let stand for at least one hour. A white crystalline precipitate shows the presence of magnesium. The precipitate is rather slow in appearing when the magnesium is present in small quantities, and may be hastened in forming by scratching the sides of the vessel with a glass rod, in which case the precipitate will appear first on the scratched places.

Sodium and potassium.—Quite small quantities of these metals may be detected by the flame test. Clean the platinum wire by dipping in hydrochloric acid and heating in the colorless flame of the alcohol lamp until it no longer colors the flame. An ordinary candle or lamp flame can not be used. Then dip the looped end of the wire in the soil solution or solid salt to be treated and put into the flame. A strong yellow color shows the presence of sodium. The violet color of the potassium is masked by the intense yellow of the sodium, and this color must, therefore, be screened out by looking at the flame through blue cobalt glass. The potassium, if present, is then recognized by the violet color of the flame.

Chlorides.—Add sufficient acid (preferably $HKSO_4$) other than hydrochloric acid to decompose the carbonates. Add silver nitrate, which gives a white insoluble precipitate of silver chloride which is soluble on the further addition of ammonia water. The addition of the acid is necessary, since silver carbonate is also a white insoluble precipitate.

Sulphates.—Add sufficient hydrochloric or nitric acid to decompose carbonates. Unless a decided excess of acid is added it will be necessary to boil the solution. The addition of barium chloride will then precipitate insoluble white barium sulphate.

Carbonates.—Dissolved carbonates are recognized by the red color imparted to the solution by phenolphthalein indicator.

Bicarbonates.—Dissolved bicarbonates are distinguished from carbonates in that they produce no reaction with phenolphthalein indicator, but show a yellow color with methyl orange indicator, which must not change to a red on the addition of one or two drops of the N/20 $KHSO_4$ solution. The volume of the N/20 $KHSO_4$ solution used is a measure of the amount of bicarbonate as explained under the quantitative method for bicarbonates.

Nitrates.—Add some crystals of ferrous sulphate to the solution. Hold the test tube at a slanting angle and pour, very carefully, concentrated sulphuric acid against the lower sides of the tube so that it will run to the bottom and form with the original solution two liquid layers. The formation of a brown ring indicates the presence of nitrates. Care should be taken not to shake the tube or add the concentrated sulphuric acid in such a way as to allow it to mix quickly with the solution, for it develops great heat and may scatter the contents of the tube with explosive violence.

Apparatus and reagents required.

1 dozen large test tubes.
1 2-inch glass funnel.
1 package filter paper, Schleicher & Schüll's No. 595, 7 cm.
1 alcohol lamp.
4 inches platinum wire.
1 square inch of blue cobalt glass.
1 bottle concentrated hydrochloric acid.
1 bottle concentrated ammonia.
1 bottle concentrated sulphuric acid.
Crystals of ammonium oxalate.
Crystals of sodium phosphate.
Crystals of ferrous sulphate.
Crystals of barium chloride.
Solution of silver nitrate.
N/20 $KHSO_4$ solution.
Phenolphthalein indicator.
Methyl orange indicator.
Red and blue litmus paper.

COLLECTION OF LABORATORY SAMPLES.

Samples of water, crusts, etc., sent to the Bureau laboratories for chemical examination, or for the purpose of checking the accuracy of the bridge, should be fully noted and described in the field note book and accompanied by a description on Form 48.

In collecting water for analysis three or four of the sample bottles protected by mailing cases should be thoroughly rinsed out and then filled. In collecting alkali crusts, only clean, firm sacks should be used, and in the case of highly concentrated sodium carbonate crusts two or three sacks, one within the other, should be used to inclose the material, because of its corrosive properties.

REPORTS.

Correspondence and weekly report.—All correspondence with the Bureau should be addressed to the Chief of the Bureau. At least once each week the head of the party should report to the Chief by letter, informing him of the progress of the work and the results accomplished, describing the new types of soil, and giving a statement of the health of the members of the party. In addition, the weekly report card (Form 49) should be filled out and returned to this office. The cards will be filed in the Bureau for ready reference, but are not to be considered as taking the place of the weekly letters. The provisional names of all soil types should be given on these cards as soon as described.

Correspondence is filed in the office by areas. Separate letters should, therefore, be written in regard to matters pertaining to different areas. Often letters are written that do not have a bearing upon any particular area, and such letters should also be written separately from letters relating to an area.

The Bureau should be kept informed of the address of all of the field men at all times, whether they are in the area to which they have been assigned, temporarily absent, or on leave of absence. Ordinarily this may be accomplished through the use of Form 49, but when absolutely necessary the telegraph may be used.

Form of a soil survey report.—A revised outline to be followed in the preparation of soil-survey reports is given below. The change in outline is one of form rather than of matter, and is made to eliminate the duplication heretofore invited in the chapters on agricultural development and agricultural conditions to emphasize the central subject of the reports, viz, the soil, and to subordinate the discussion of geology. The chapter on physiography and geology has been omitted, the subject being divided between Chapters I and IV. The latter (soils), which has heretofore been very brief, may now be greatly amplified. What is wanted in this chapter is a broad, general discussion of the soils as related to geology and to each other, leaving the details to be brought out in the next chapter, which is much the same as in the old outline. The chapter on agricultural methods has also been eliminated, the subject being transferred to Chapter V, where differences of methods on the several types should be clearly brought out.

This outline is given as a guide in the arrangement of the report, and should be followed as closely as circumstances will permit. It is understood of course that the headings will necessarily have to be changed somewhat in different districts, and that the relative importance of the different chapters will vary with the locality. The matter should be presented in a terse style, and no more words used than are absolutely necessary to convey the meaning, being careful, however, to treat each subject so that all important phases may be brought out and clearly stated. In order to attain this, the different chapters should be revised several times if necessary, so that all important matters may be considered and all unnecessary words eliminated. A careful consideration of this matter of style in writing is enjoined upon all members of the Bureau charged with the preparation of reports. The material for the report should be collected, and the writing of the report should be done, as far as practicable, before the party leaves the area. It is desirable that the manuscripts should be legible and written upon sheets of uniform size. In the future pads for this express use will be furnished. Those charged with the preparation of reports are particularly cautioned against crowding the lines. Ample space, at least half an inch, should be allowed between the lines to facilitate interlineations in correction.

Outline of soil survey report.—The outline of chapters is as follows:

I. Description of the area.

Give the location and boundaries of the area, and describe the general topographic features and regional drainage, character and source of population, present condition as to settlement, chief towns, transportation facilities, markets, etc

II. Climate.

III. Agriculture.

Give an account of the early agriculture, noting changes in crops grown and in agricultural practices, leading up to a discussion of the general type of agriculture at the present time; character and value of the principal products, recognition of adaptation of soils to crops, rotation of crops, agricultural methods as adapted to present conditions, character and cost of labor, tenure and size of farms, value of farm lands, and, finally, suggestions for improvement in the agriculture of the area.

IV. Soils.

Enter into a general discussion of the soils of the area, showing broadly their relation to the geological formations and to each other, to drainage, erosion, and other formative or modifying agencies, their classification and distribution, and their correlation with the soils of other areas.

V. Description of individual soil types.

Give a detailed and full description of the soil and subsoil, noting texture, structure, color, depth, and ease of cultivation. Follow this with a statement as to the location of soil in the area, topographic and drainage features, origin and process of formation, peculiar mineral or chemical features—as alkali; native vegetation, unusual or characteristic crops to which adapted, crops grown and minimum, maximum, and average yields, cultural methods peculiar to the type and suggestions for new methods, fertilizer practice, and agricultural condition and value of lands as influenced by the individual soil type.

VI. Irrigation.

Discuss the sources of water supply, character of the water, means of distribution, approximate area under irrigation, opportunity for extension, and methods and cost of irrigation.

VII. Drainage.[a]

Describe position of water table, injury from seepage, character of underground water, and reclamation of damaged areas or of swamp or marsh lands.

VIII. Alkali.

Give the location of alkali areas, origin of alkali in the area, its chemical composition and vertical distribution, approximate area abandoned on account of the accumulation of alkali, and methods suggested for reclamation.

IX. Summary.

Write a brief paragraphical résumé of salient points brought out in the report, including soil adaptations, deductions from the study of conditions, and suggestions for improvement or changes in the agricultural methods and in the crops grown.

DESCRIPTIONS OF ESTABLISHED SOIL TYPES.

[The average mechanical analysis of each type of soil is given immediately after the description. The number in parenthesis immediately following "soil" and "subsoil" indicates the number of samples used in obtaining the average. The numbers above the columns refer to the grades into which the soil is separated, as given in the scheme of soil classification.]

SOILS OF THE ATLANTIC AND GULF COASTAL PLAINS.

The Atlantic and Gulf Coastal Plains together constitute one of the most important physiographic divisions of the United States. The Atlantic Coastal Plain extends from the New England States southward to the Florida Peninsula, where the Gulf Coastal Plain begins and extends thence westward to the Mexican boundary line. It is, however,

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[a] A separate chapter should be given to this subject only in areas where an underground water map is made or where the seepage or drainage conditions are of such general importance that the question can not be treated in connection with the description of individual soil types.

discontinuous, being interrupted by the alluvial bottoms of the Mississippi River. From the coast the Atlantic Plain extends inland to the margin of the Piedmont Plateau—that is, to a line passing through Trenton, Baltimore, Washington, Richmond, Raleigh, Columbia, Augusta, and Macon. In its northern extension it is represented by a narrow belt, but widens in New Jersey and attains its maximum breadth of about 200 miles in North Carolina. The Gulf Plain extends up the Mississippi to the mouth of the Ohio, its inner boundary line passing through or near Montgomery, Iuka, Cairo, Little Rock, Texarkana, Austin, and San Antonio.

The surface is that of a more or less dissected plain marked by few hills, and slightly terraced with bluffs along streams. The inner margin of the Coastal Plain is usually from 200 to 300 feet above tidewater, but sometimes rises to 500 feet. The drainage here is usually well established, and the surface is rolling to hilly, and consequently carved and eroded. There is a wide belt bordering the coast where the elevations are mostly under 100 feet. In the northern part, where the Coastal Plain is narrow and deeply indented with tidal estuaries, drainage is usually well established and the surface is rolling, but in the broad southern extension, where the seaward slope is hardly more than 1 foot to the mile, drainage is apt to be deficient. Here rain water often remains upon the surface for a considerable time, although the conditions are not comparable with those of a true swamp. The soils in this level section, while composed largely of sand, are compact, usually deficient in organic matter, and not very productive. Many of the flat interstream areas possess such poor drainage that true swamps, such as the Dismal and Okefenokee, have been formed. Near the coast and along the tidal estuaries extensive marshes, separated from the ocean by sand barriers, are found.

The Coastal Plain is made up of unconsolidated gravels, sands, and sandy clays, with less frequent beds of silts and heavy clays. These deposits have been derived mainly from the erosion of the Piedmont Plateau and other inland areas. The materials have been transported and deposited beneath the sea and subsequently exposed by the uplift of the ocean floor. In the more northern parts of the Coastal Plain and even as far south as Virginia, the character of the deposits has been modified by glacial action and the flooded condition of the streams resulting from the melting of the ice.

The Coastal Plain materials range in age from Cretaceous to Recent Although extensive areas of the older sediment are exposed at the surface to form soils, still by far the greater part of the materials is Quaternary or Recent in age.

The soils are for the most part composed of sands and light sandy loams, with occasional deposits of silts and heavy clays. The heavy clays are found principally near the inner margin of the Coastal Plain. The silts, silty clays, and black calcareous soils upon which the rice and sugar-cane industries of southern Louisiana and Texas are being so extensively developed have no equivalents in the Atlantic division. As a result of differences in the method of deposition, subsequent erosion, and drainage conditions, the Coastal Plain frequently presents a great diversity of soil types and soil series with complicated relationships between them. The following series have so far been recognized: Galveston, Norfolk, Portsmouth, Orangeburg, Susquehanna, Lufkin, Houston, and Gadsden. In addition there are a number of miscellaneous types which have not as yet been brought into series.

NORFOLK SERIES.

The Norfolk series consists of light-colored sandy soils underlain by yellow or orange sand or sandy clay subsoils. Where the drainage is insufficient, the subsoil is often mottled. The members of this series are distinguished from those of the Portsmouth series by the lighter color of the surface material and from those of the Orangeburg series by the yellow color of the subsoils. The members of the Norfolk series, with few exceptions, are special purpose rather than general farming soils. This series comprises the most important truck soils of the Coastal Plain.

Norfolk gravel.[a]—The soil occurs as hills, narrow bands, or outcrops of grável consisting of 30 to 60 per cent of rounded waterworn gravel with interstitial material varying from sand to sandy loam or loam. The subsoil is usually a gravelly sand or sandy loam, but locally consists of stiffer and more clayey material. The type is formed through denudation of gravel layers deposited as shallow-water sediment or as river wash or delta. It is a poor, unproductive soil, generally occupying slopes, and should remain in forest.

[a] Mapped as Susquehanna gravel. This name will be used only in Maryland in the future.

	Acres.		Acres.
Calvert County, Md	3,900	Prince George County, Md	41,470
Cecil County, Md	45,600	Raleigh to Newbern, N. C	11,410
Harford County, Md	12,930	St. Mary County, Md	7,350
Kent County, Md	12,490	Trenton, N. J	192
Long Island, N. Y	3,328		

Norfolk gravelly loam.—The soil is a gray sandy loam from 6 to 30 inches deep, containing relatively large proportions of coarse to medium sand and from 15 to 50 per cent of gravel and iron concretions. The subsoil varies from a sticky sandy loam to a light sandy clay with an admixture of varying quantities of gravel. The gravel generally is mixed evenly throughout soil and subsoil, but occasionally covers the surface. This type occupies terraces and gently to steeply rolling plains marked with occasional ridges and hills. The surface configuration, combined with open texture, gives the type excellent drainage. It supports a scattered growth of oak and pine. Corn, cotton, rye, buckwheat, truck crops, peaches, and wrapper tobacco are grown, according to the locality, but the yields are very low.

	1	2	3	4	5	6	7
Soil (11)	5	13	12	17	18	25	9
Subsoil (11)	3	9	11	14	18	27	17

	Acres.		Acres.
Connecticut Valley, Conn. and Mass	[a] 59,284	Lancaster County, Pa	[b] 4,000
Crystalsprings, Miss	48,768	Lebanon, Pa	[b] 13,350
Hanover County, Va	1,344	Macon County, Ala	56,960
		Montgomery County, Ala	1,536

Norfolk coarse sand.—The soil is a loose, incoherent, gray coarse sand 8 inches deep, containing 10 per cent or more of gravel, underlain by a subsoil of the same material frequently containing iron crusts. The type occurs as level plains or broken slopes, and is not very productive, though used to some extent for tobacco, peaches, and truck.

	1	2	3	4	5	6	7
Soil (18)	9	20	20	23	8	8	4
Subsoil (14)	10	26	19	21	6	10	6

	Acres.		Acres.
Calvert County, Md	[c] 24,500	Prince George County, Md	[c] 37,420
Connecticut Valley, Conn. and Mass	[c] 72,008	Rhode Island	26,304
Dodge County, Ga	12,416	St. Mary County, Md	[c] 3,450
Long Island, N. Y	1,856	Salem, N. J	[c] 18,280
Macon County, Ala	42,752	Trenton, N. J	[c] 512

[a] Mapped as Chicopee gravel loam. [b] Mapped as Donegal gravelly loam.

[c] Mapped as Windsor sand, which name will not again be used except in Maryland.

Norfolk coarse sandy loam.—The soil to a depth of 8 inches consists of a brown to yellowish coarse sandy loam. The subsoil is a yellow sandy loam extending to a depth of about 24 inches, where it rests upon coarse sand and gravel. Both soil and subsoil contain about 25 per cent of small waterworn gravel, chiefly quartz. The surface is level or gently sloping. The areas of this type represent outwash plains of sand and gravel mixed with finer material. Fair crops of corn, grain, grasses, and especially of small fruits are produced, but failures occur in years of drought.

	1	2	3	4	5	6	7
Soil (6)	9	24	14	10	10	22	9
Subsoil (4)	11	38	20	11	4	9	5

	Acres.
Connecticut Valley, Conn. and Mass	27,904
Long Island, N. Y	64,896
Rhode Island	[a]82,816
Yorktown, Va	4,288

Norfolk sand. [b]—The soil is a coarse to medium incoherent gray or yellowish sand, resting on a yellow sand subsoil of about the same texture, and extending to a depth of 3 feet or more. This is a common type on the low, flat river necks and forelands of the Atlantic and Gulf Coastal Plains, along the valley slopes of the streams, and covering extensive level areas in the uplands. These different positions have a marked influence upon its productiveness, the upland areas giving the lowest yields. It is well drained, matures crops very early, and has such a poor water-retaining power that general farm crops can not be grown with any great success, except upon the low-lying areas where the water table comes within a few feet of the surface. Corn yields but 5 to 10 bushels per acre and wheat not to exceed 5 to 6 bushels. It is a good early truck soil, especially adapted to light truck crops. It is also used for small fruits and peaches, although not so well adapted to these latter as some of the other soils of the series. Many watermelons are grown upon this soil in the Southern States. In the Connecticut Valley and in Florida a very fine grade of cigar-wrapper tobacco is produced upon this soil. In Maryland it produces a fine grade of the Maryland export tobacco. In North and South Carolina it produces a very fine grade of cigarette tobacco, but is not as well adapted to this as is the Norfolk sandy loam.

[a] Mapped as Warwick sandy loam.

[b] See also Norfolk fine sand.

	1	2	3	4	5	6	7
Soil (57)	3	15	22	38	10	8	4
Subsoil (46)	3	16	21	37	9	8	5

	Acres.		Acres.
Anderson County, Tex	55,808	Lancaster County, S. C	38,528
Bainbridge, Ga	29,696	Leon County, Fla	106,688
Biloxi, Miss	76,032	Long Island, N. Y	77,120
Calvert County, Md	58,000	Macon County, Ala	22,016
Cecil County, Md	46,600	Mobile, Ala	134,592
Charleston, S. C	1,088	Montgomery County, Ala	4,288
Connecticut Valley, Conn. and Mass	[a] 95,304	Orangeburg, S. C	86,080
Dallas County, Ala	7,168	Prince George County, Md	23,630
Darlington, S. C	71,104	Raleigh to Newbern, N. C	53,310
Dodge County, Ga	175,296	St. Mary County, Md	27,500
Dover Del	5,632	Salem, N. J	78,410
Fort Valley, Ga	33,792	San Antonio, Tex	3,904
Gadsden County, Fla	93,120	Sumter County, Ala	15,296
Gainesville, Fla	139,328	Tangipahoa Parish, La	896
Harford County Md	2,470	Trenton, N. J	50,880
Houston County, Tex	4,544	Willis, Tex	8,560
Kent County, Md	30,760	Worcester County, Md	45,312

Norfolk fine sand.—The soil is a light-brown or gray fine sand about 8 inches deep, loose and incoherent when dry, but packing slightly when wet. The subsoil is of much the same texture, slightly heavier, lighter in color, and somewhat more adhesive. The type occurs as low, rolling hills and level areas, and is generally well drained. The soil is adapted to about the same class of crops as the Norfolk sand, but is generally somewhat more productive. It is the best early truck soil of the Coastal Plain, but produces only fair crops of corn and cotton. In Florida a fine grade of wrapper tobacco is grown on this soil.

[a] Mapped as Hartford sandy loam, which name will not be used outside of the Connecticut Valley.

	1	2	3	4	5	6	7
Soil (35)	0	3	10	56	14	11	5
Subsoil (28)	0	2	9	53	16	14	5

	Acres.		Acres.
Anderson County, Tex	138,880	Leon County, Fla	28,608
Biloxi, Miss	56,896	Montgomery County, Ala	9,856
Connecticut Valley, Conn. and Mass	[a] 17,284	Norfolk, Va	[b] 20,864
Charleston, S. C	61,504	Ouachita Parish, La	192
Craven, N. C	[b] 88,192	Perquimans and Pasquotank Counties, N. C	6,976
Dallas County, Ala	23,872	Perry County, Ala	[b] 4,160
Duplin County, N. C	117,440	Prince George County, Md	[c] 36,190
Houston County, Tex	79,872	Salem, N. J	[d] 15,710
Jackson, Miss	320	Trenton, N. J	[d] 27,584
Jacksonville, Tex	38,528	Worcester County, Md	22,400
Lee County, Tex	41,856		

Norfolk sandy loam.—This type consists of a coarse to medium yellow or gray sand or light sandy loam soil 12 to 20 inches deep, resting on a yellow light sandy clay subsoil. It occupies level or gently rolling land. The soil is too light for general farm crops, and corn yields on the average not over 10 bushels per acre. It is adapted to sweet and Irish potatoes, peanuts, and truck crops. In the Connecticut Valley and in Florida it produces a fine cigar-wrapper tobacco and in North Carolina bright yellow tobacco and cotton.

	1	2	3	4	5	6	7
Soil (28)	4	5	14	31	18	11	7
Subsoil (23)	4	12	10	22	12	12	26

	Acres.		Acres.
Bainbridge, Ga	24,576	Henderson County, Tenn	1,984
Connecticut Valley, Conn. and Mass	[e] 46,462	Macon County, Ala	9,408
Craven, N. C	27,288	Montgomery County, Ala	32,896
Darlington, S. C	[f] 65,024	Orangeburg, S. C	126,592
Dodge County, Ga	105,792	Raleigh to Newbern, N. C	[g] 216,580
Gadsden County, Fla	50,816	Salem, N. J	[h] 16,790
Gainesville, Fla	86,784	Trenton, N. J	[h] 8,640
Hanover County, Va	88,256	Woodville, Tex	52,864
		Yorktown, Va	94,016

[a] Mapped as Podunk fine sandy loam.

[b] Mapped as Norfolk sand.

[c] Mapped as Westphalia sand.

[d] Mapped in part as Elsinboro fine sand and in part as Westphalia sand.

[e] Mapped as Enfield sandy loam, which name will not be used outside of the Connecticut Valley.

[f] Mapped as Norfolk sandy soil.

[g] Mapped in part as Norfolk sandy soil and in part as Selma silt loam.

[h] Mapped as Quinton sandy loam.

Norfolk fine sandy loam.—The soil consists of a pale-yellow or gray fine sandy loam 6 to 8 inches deep, underlain by a yellow fine sandy loam subsoil, grading into a light sandy clay at an average depth of about 18 inches. It occurs in level plains and rolling uplands and generally has good drainage. It gives a moderate yield of corn, and is very well adapted generally to late truck crops and in parts of the South to cotton and to bright yellow tobacco. This soil is not as valuable for early truck as the Norfolk fine sand, but is an excellent medium to late truck soil. In North Carolina it is esteemed a better tobacco soil than the Norfolk sandy loam and fully equal, if not somewhat superior, to the Norfolk fine sand.

	1	2	3	4	5	6	7
Soil (73)	1	3	5	38	24	22	8
Subsoil (74)	1	3	4	29	17	21	24

	Acres.		Acres.
Anderson County, Tex	224,640	Macon County, Ala	21,952
Bainbridge, Ga	93,248	McNeill, Miss	81,472
Biloxi, Miss	171,968	Mason County, Ky	832
Boonville, Ind	[a] 22,848	Montgomery County, Ala	39,552
Calvert County, Md	[b] 5,220	Mobile, Ala	7,168
Charleston, S. C	47,680	Nacogdoches, Tex	19,008
Craven, N. C	155,136	Norfolk, Va	38,144
Dallas County, Ala	163,392	Orangeburg, S. C	4,480
Darlington, S. C	[c] 25,600	Perquimans and Pasquotank counties, N. C	43,968
De Soto Parish, La	244,992	Prince George County, Md	[b] 9,660
Duplin County, N. C	180,032	Raleigh to Newbern, N. C	36,100
Fort Valley, Ga	[d] 23,488	St. Mary County, Md	[b] 8,500
Gadsden, Fla	28,096	Sumter County, Ala	48,128
Hanover County, Va	39,232	Union County, Ky	[e] 2,176
Houston County, Tex	145,408	Willis, Tex	[f] 107,180
Leon County, Fla	67,328	Yorktown, Va	144,064
Lufkin, Tex	6,016		

[a] Mapped as Miami fine sandy loam.

[b] Mapped as Norfolk loam, but now brought into the proper place in the Norfolk series.

[c] Mapped as Ayden fine sandy loam.

[d] Mapped as Norfolk sandy loam

[e] Mapped as Sturgis fine sandy loam.

[f] Part of this occurring on the uplands was mapped as Willis sand, the remainder occupying a low position along the river was mapped as Norfolk fine sandy loam. It is recognized now that these two areas should have been combined.

Norfolk loam.[a]—The soil is a brown loam or fine sandy loam, usually containing a very small amount of fine gravel. The subsoil is a yellow loam containing considerable sand, which is frequently underlain by a medium grade of yellow sand or by gravel. The type occupies level areas, usually terraces along rivers and tidal estuaries. The soil is easily tilled, well drained, and produces fair yields of general farm crops. It is especially well adapted to sugar corn, peas, and tomatoes for canning purposes, and also to peaches. It is too heavy a soil for early truck, and not sufficiently heavy to be classed as a general farming soil.

	1	2	3	4	5	6	7
Soil (26)	1	6	9	24	17	30	11
Subsoil (26)	1	6	9	20	15	29	19

	Acres.		Acres.
Biloxi, Miss	68,416	Mobile, Ala	47,104
Calvert County, Md	[b] 10,900	Norfolk, Va	23,872
Dover, Del	66,752	Perry County, Ala	[b] 14,720
Lockhaven, Pa	3,648	Prince George County, Md	[b] 4,830
Long Island, N. Y	[c] 100,096	St. Mary County, Md	[b] 17,500
Mason County, Ky	896	Worcester County, Md	[b] 54,848

Norfolk silt loam.—This soil type consists of a brown loam 10 inches deep, underlain by a heavy yellow loam subsoil, both containing a rather high percentage of silt. It occurs as level or gently rolling uplands or terraces. It is one of the most valuable soils of the Atlantic Coastal Plain for general farm crops, and is best adapted to wheat, corn, and grass. In New Jersey this soil produces as high as 25 or 35 bushels of wheat, 1 to 2 tons of hay, and from 50 to 70 bushels of corn per acre. It is esteemed an excellent soil for dairy farming. On the Eastern Shore of Maryland the yields are almost as high as in New Jersey. In southern Maryland the yields are much less, wheat producing from 12 to 18 bushels and corn 25 to 40 bushels per acre, while the yield of hay is proportionally small. It is believed that this difference in productiveness is due almost entirely to the methods of cultivation.

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[a] See also Norfolk fine sandy loam, page 51.

[b] Mapped as Sassafras sandy loam.

[c] Mapped in part as Sassafras sandy loam and in part as Sassafras gravelly loam, which names will hereafter only be used in Maryland and New Jersey.

	1	2	3	4	5	6	7
Soil (29)	1	3	4	10	14	54	12
Subsoil	0	3	4	9	13	51	19

	Acres.		Acres.
Calvert County, Md	[a] 8,850	Perquimans and Pasquotank counties, N. C	9,344
Cecil County, Md	[a] 50,500	Prince George County, Md	[a] 9,090
Chester County, Pa	6	Salem, N. J	[b] 108,140
Darlington, S. C	[a] 26,880	San Antonio, Tex	24,128
Dover, Del	32,960	St. Mary County, Md	[a] 16,200
Harford County, Md	[a] 29,810	Trenton, N. J	[b] 88,384
Kent County, Md	[b] 67,200	Worcester County, Md	[a] 14,400
Lockhaven, Pa	5,824		

Norfolk clay loam.—The soil consists of about 6 inches of dark-brown clay loam, underlain by a very dense waxy clay of a dark reddish-brown color. At about 24 inches thin lenses of very fine sand occur and the color changes to a mottled grayish blue. The surface is flat and the elevation is only about 10 feet above sea level. Much of the type is imperfectly drained. The type is best adapted to grass and small grains, and formerly produced large yields of wheat. At present the yield rarely exceeds 10 bushels per acre.

	1	2	3	4	5	6	7
Soil (1)	1	3	8	23	7	34	23
Subsoil (1)	0	4	6	18	7	32	33

	Acres.
Yorktown, Va	1,856

Norfolk clay.—The soil consists of from 3 to 6 inches of heavy, very fine sandy loam or loam, and the subsoil of a stiff, mottled yellow clay. The surface is generally level and the drainage is poor, and artificial drainage is often necessary before crops can be grown. The soil almost invariably clods unless plowed in just the proper condition of moisture, although when properly drained and carefully cultivated it is quite productive, yielding from 1 to 2 tons of hay, 20 to 40 bushels of corn, and 1 bale of cotton per acre.

[a] Mapped as Sassafras loam. It is recognized clearly now that this belongs to the Norfolk series. The name Sassafras loam will be used hereafter only in Maryland and New Jersey.

[b] Mapped in part as Sassafras loam and Sassafras gravelly loam. The latter name will not again be used, and similar soils will in the future be mapped as Norfolk silt loam with a gravel symbol and the gravelly phase described in the report, except in Maryland and New Jersey, where it will be mapped as Sassafras loam with a gravel symbol.

	1	2	3	4	5	6	7
Soil (5)	1	3	3	18	16	36	23
Subsoil (7)	0	1	2	15	9	27	43

	Acres.		Acres.
Craven, N. C	[a] 9,600	Fort Valley, Ga	[a] 640
Dallas County, Ala	61,312	Montgomery County, Ala	33,856

PORTSMOUTH SERIES.

The Portsmouth series is characterized by dark-gray to black surface soils, underlain by yellow, gray, or mottled yellow and gray subsoils. The dark color of the soils is due to an accumulation of organic matter during an earlier or existing swampy condition. This series may be considered as intermediate between the light-colored Norfolk soils on the one hand and the Peat and Swamp areas on the other. The members of the series occupy depressed areas, or areas so flat that the water table is at or near the surface, except where artificial drainage has been resorted to. When drained the Portsmouth soils are well adapted to corn and to certain truck crops, particularly strawberries, cabbages, and onions.

Portsmouth sand.—The soil is a black, brown, or dark-gray loamy sand, about 12 inches deep, usually containing a large amount of organic matter. The subsoil is a gray or mottled drab, white, and yellow sticky sand, underlain at from 24 to 48 inches by a compact and impervious stratum of sand having the properties of a hardpan. Occasionally the subsoil is so saturated with water as to resemble quicksand. This type occurs in nearly level upland areas with poor drainage and represents former lake or swampy areas. Corn is the principal crop. It is adapted to berries, particularly to strawberries, and to cabbage, onions, and other heavy or late truck crops.

	1	2	3	4	5	6	7
Soil (11)	1	10	25	46	7	6	4
Subsoil (9)	1	10	26	49	5	4	5

	Acres.		Acres.
Bainbridge, Ga	3,456	Gadsden, Fla	8,640
Craven, N. C	11,072	Norfolk, Va	2,048
Dover, Del	640	Worcester County, Md	41,024
Duplin County, N. C	38,016		

Portsmouth fine sand.—The soil consists of 16 inches of fine sand of a dark-gray or black color. The dark color is the result of decayed organic matter. Where the usual drainage conditions prevail, the

[a] Mapped as Selma clay.

subsoil is a chocolate-brown fine sand, similar in texture to the soil and occasionally cemented by iron. Below 3 feet a pure white sand, locally known as quicksand, is usually found. This type is of sedimentary origin and occupies level uplands. The natural surface drainage is but imperfectly established, and water stands at an average depth of 2 feet below the surface at all times, while after heavy rains the surface is flooded for days at a time. The natural vegetation is longleaf pine, with an undergrowth of palmetto and gallberry bushes. In some places scrub oak is a prominent tree growth. But little of the type is under cultivation.

	1	2	3	4	5	6	7
Soil (2)	0	3	9	64	9	6	9
Subsoil (2)	0	3	9	65	9	5	8

	Acres.
Gainesville, Fla	35,840

Portsmouth sandy loam.—This type consists of a black, brown, or dark-gray sandy loam soil, about 12 inches deep, frequently containing a very large quantity of organic matter, underlain by a gray or mottled sandy clay subsoil, which in turn is underlain usually by a compact sand sometimes having the properties of a hardpan. The type occupies level or slightly depressed areas in the uplands and the drainage is usually poor. When drained this type of soil is adapted to corn, potatoes, and truck crops, particularly strawberries.

	1	2	3	4	5	6	7
Soil (21)	5	11	12	29	13	18	12
Subsoil (18)	2	8	10	25	12	21	22

	Acres.		Acres.
Craven, N. C	46,208	Orangeburg, S. C	131,904
Darlington, S. C	[a] 133,696	Raleigh to Newbern, N. C	[b] 37,860
Dover, Del	50,304	San Antonio, Tex	15,488
Gainesville, Fla	40,384	Worcester County, Md	9,856
Norfolk, Va	30,016	Yorktown, Va	20,032

Portsmouth fine sandy loam. The soil is a black or rusty brown, mucky, fine sandy loam, compact, wet, and heavy, with an average depth of about 12 inches. Large quantities of organic matter are usually present, in all stages of decomposition. Under continued

[a] Mapped as Goldsboro compact sandy loam. This also includes the Selma heavy silt loam, which should not have been separated from the Goldsboro compact sandy loam.

[b] Mapped as Goldsboro compact sandy loam.

cultivation the soil becomes lighter in both color and texture and the sand content more pronounced. The subsoil is usually a mottled drab and yellow sandy clay, massive and sticky, with a depth of more than 36 inches, and is underlain occasionally by a layer of very fine white or gray sand. Where the type occurs within sand areas, the subsoil often consists entirely of sand. It is characterized by level or slightly depressed surface features. Lack of drainage is responsible for the existence and peculiar characteristics of the type. In most cases artificial drainage is impracticable, owing to the lack of fall. The type supports a heavy growth of cypress, gum, magnolia, and other water-loving trees and undergrowth. When cleared and properly drained, Irish potatoes and cabbages are successfully grown, especially the latter. Cotton and corn give fair yields in favorable situations. The type is well adapted to onions and some of the berry fruits.

	1	3	3	4	5	6	7
Soil (6)	0	2	4	53	12	17	12
Subsoil (6)	0	2	4	48	9	13	24

	Acres.		Acres.
Charleston, S. C	32,064	Raleigh to Newbern, N. C	[a] 18,980
Duplin County, N. C	66,112	Yorktown, Va	29,760
Perquimans and Pasquotank counties, N. C	25,472		

Portsmouth loam.—This type consists of a dark-gray to black fine-textured loam soil, about 12 inches deep, underlain by a gray or somewhat mottled heavy loam subsoil, grading sometimes into a mottled gray or yellow silty clay. It occupies flat, upland areas, with naturally very poor drainage, but when drained and properly cultivated is well suited, according to locality, to corn, cotton, sugar cane, and forage plants.

	1	2	3	4	5	6	7
Soil (7)	0	2	3	19	17	42	17
Subsoil (7)	0	1	2	17	16	39	24

	Acres.		Acres.
Craven, N. C	[b] 45,504	Perquimans and Pasquotank counties, N. C	41,536
Duplin County, N. C	8,448		
McNeill, Miss	3,328		

[a] Mapped as Selma heavy silt loam.

[b] Mapped as Portsmouth clay, but the soil is too light in texture to be classed as a clay.

Portsmouth silt loam.—The soil consists of a gray to dark-brown friable silt loam about 9 inches deep It is frequently compact and inclined to puddle, and if plowed when too wet it forms clods, though these break down quite readily in subsequent cultivation. The subsoil is a gray or mottled gray and yellow heavy silt loam, which in the lower depths sometimes becomes heavier and more greasy and waxy in character. The type occurs as flat, slightly depressed or low lying areas, which generally require drainage for successful cultivation, and was formed by deposition of fine materials in comparatively quiet water during the more or less complete submergence of the Atlantic Coastal Plain. When well drained it is adapted to corn, hay, and small grain and in the South to such vegetables as cabbage, kale collards, etc. It also gives moderate yields of cotton

	1	2	3	4	5	6	7
Soil (18)	.0	1	3	5	9	63	17
Subsoil (18)	0	1	2	4	9	59	24

	Acres
Cecil County, Md	[a] 7 000
Chester County, Pa	512
Dover, Del	[a] 6,016
Harford County, Md	[a] 11,370
Kent County, Md	[a] 27,840
Mason County, Ky	[a] 896
Norfolk Va	[b] 55,488
Perquimans and Pasquotank Counties, N. C	110,016
Prince George County, Md	[a] 1,450
Salem, N J	[a] 11,240
Worcester County Md	[a] 50,432

Portsmouth clay loam.—The soil is a clay loam of ashy gray to dark brownish color and about 6 inches deep. It grades abruptly into a dense waxy clay which extends to a depth of 24 inches. Below 24 inches the subsoil contains pockets of fine sand. The type occupies flat or troughlike depressions along tide water, and the drainage is inadequate. It is derived from marine deposits. The soil is used for the production of corn, wheat, and grass, of which moderate yields are secured.

	1	2	3	4	5	6	7
Soil (2)	0	0	4	27	8	38	21
Subsoil (2)	0	3	5	29	4	38	21

	Acres
Yorktown Va	2,176

[a] Mapped as Elkton clay

[b] Mapped in part as Leonardtown loam and in part as Leonardtown gravelly loam.

ORANGEBURG SERIES.

The Orangeburg series is derived largely, but not entirely, from the Lafayette mantle of gravels, sands, and sandy clays. The surface soils are usually gray to brown in color and are invariably underlain at a depth of 3 feet or less by a red or yellowish-red sandy clay. The prevailing red color of the subsoil is the characteristic feature distinguishing the Orangeburg series from the Norfolk series. The red soils appear to possess a higher producing power and are generally stronger than the corresponding soils of the Norfolk series. The Orangeburg soils may be considered as the Coastal Plain equivalent of the Cecil series of the Piedmont Plateau.

Orangeburg sand.—The soil is a gray or reddish sand, of medium texture, from 6 to 8 inches deep, resting upon a reddish-yellow sandy subsoil, which in turn is underlain at a depth of from 15 to 36 [a] inches by a red sandy clay. The soil usually contains some iron concretions. This type usually occupies gently rolling areas and has good natural drainage. It gives fair yields of corn and cotton, but is best adapted to early truck, peaches, and wrapper tobacco.

	1	2	3	4	5	6	7
Soil (14)	2	13	15	38	15	7	6
Subsoil (14)	2	14	25	27	11	7	22

	Acres.		Acres.
Bainbridge, Ga	22,592	Montgomery County, Ala	17,920
Darlington, S. C	[b] 9,984	Orangeburg, S. C	45,312
Gadsden Fla	31,552	Sumter County, Ala	44,[illegible]8
Leon County, Fla	6,912		

Orangeburg fine sand.—The soil is a brownish-red to grayish-red fine sand to fine sandy loam with an average depth of 2 feet. The subsoil is a red sandy clay extending to a depth of 40 inches or more. The type occurs on the undulating and flat tops of hills and ridges, and owing to its location the drainage is good. The type is derived from the weathering of unconsolidated material of late Cretaceous and early Tertiary time. The soil is easily worked under a wide range of moisture conditions and is largely under cultivation. In favorable seasons an average yield of one-half bale of cotton is secured, while the yield

[a] Where the sand is more than 36 inches deep this material should be called Norfolk sand

[b] Mapped as Orangeburg sandy loam.

of corn is about 35 bushels per acre. The soil is also well adapted to peaches and plums and is used to some extent for the production of melons.

	1	2	3	4	5	6	7
Soil (4)	0	2	10	48	18	11	11
Subsoil (4)	0	1	6	40	22	11	20

	Acres.		Acres.
Dallas County, Ala	13,312	Lee County, Tex	69,696
Houston County, Tex	704	San Antonio, Tex	36,736

Orangeburg sandy loam.—This type consists of a coarse to medium red or dark-brown sand or light sandy loam, from 4 to 15 inches in depth,[a] resting on a red sandy clay subsoil usually containing small gravel and iron concretions. The type occupies rolling to level upland ridges and slopes. It is adapted to general farming, giving good yields of cotton and corn, and rather small yields of wheat and oats. In South Carolina it is used for bright yellow tobacco, and in Florida, Alabama, and Texas for cigar wrapper and filler leaf.

	1	2	3	4	5	6	7
Soil (14)	3	13	21	25	14	14	8
Subsoil (16)	2	8	14	17	11	13	33

	Acres.		Acres.
Darlington, S. C	[b] 6,592	Montgomery County, Ala	22,912
De Soto Parish, La	192	Orangeburg, S. C	16,064
Macon County, Ala	110,144	Paris, Tex	12,224
McNeill, Miss	7,296	Woodville, Tex	1,152

Orangeburg fine sandy loam.—This type consists of a gray or brown fine sand or light fine sandy loam soil from 4 to 15 inches deep,[a] underlain by a red sandy clay subsoil. This type occupies level and rolling to hilly areas in uplands and has good drainage. The soil is well adapted to cotton, gives fair yields of corn, and is particularly well adapted to truck crops, peaches, and in Texas to Cuban filler tobacco. It is the principal peach soil of the Fort Valley area, Georgia.

[a] Where the sandy layer is less than 4 inches deep the soil should be called Orangeburg clay.

[b] Mapped as Orangeburg loam, but the surface soil is too coarse, loose, and incoherent for the true Orangeburg loam.

	1	2	3	4	5	6	7
Soil (42)	1	3	6	39	23	18	8
Subsoil (44)	1	3	4	27	17	15	31

	Acres.		Acres.
Anderson County, Tex	102,080	Leon County, Fla	73,920
Bainbridge, Ga	36,480	Lufkin, Tex	6,400
Biloxi, Miss	3,008	Miller County, Ark	224,640
Crystalsprings, Miss	17,280	Mobile, Ala	26,880
De Soto Parish, La	6,976	Montgomery County, Ala	6,208
Dallas County, Ala	159,040	Nacogdoches, Tex	16,320
Duplin County, N. C	7,616	Ouachita Parish, La	172,800
Fort Valley, Ga	[a] 24,896	Paris, Tex	69,184
Gadsden, Fla	[a] 37,248	Perry County, Ala	[a] 196,288
Houston County, Tex	57,088	Sumter County, Ala	107,264
Jacksonville, Tex	18,752	Tangipahoa Parish, La	84,672
Lee County, Tex	57,920		

Orangeburg clay.—This type is a red loam or clay loam soil, with an average depth of 8 inches, resting on a stiff, tenacious reddish-brown or red clay subsoil. In small local areas a sandy covering is sometimes found, but the red clay must be within 4 inches of the surface. Generally the surface is rolling or hilly and the drainage is excellent. The native growth is hardwood. Cotton and corn are the principal crops, the former yielding from one-third to 1 bale and the latter from 15 to 45 bushels per acre. The better areas of this type are believed to be adapted to the production of a fine grade of domestic Cuban filler tobacco.

	1	2	3	4	5	6	7
Soil (18)	2	4	4	22	22	23	23
Subsoil (21)	1	2	3	17	18	23	35

	Acres.		Acres.
Anderson County, Tex	35,904	Macon County, Ala	69,504
Dallas County, Ala	9,024	Nacogdoches, Tex	16,704
Fort Valley, Ga	31,168	Paris, Tex	59,136
Houston County, Tex	7,488	Perry County, Ala	82,752
Jacksonville, Tex	4,096	San Antonio, Tex	27,520
Lee County, Tex	10,688	Sumter County, Ala	12,800

GALVESTON SERIES.

The Galveston series includes the barrier islands or bars, shore-line deposits, and low-lying marshes of the immediate coast line. The barrier bars consist of white sand thrown beyond the reach of normal tides by wave action and further modified by winds. The soils of the

[a] Mapped as Orangeburg sandy loam.

marshes, consisting of sandy loams, loams, and clays, have been built up by the deposition of silt and clay carried in by streams, by wind-blown sand from the adjoining sand areas, and by the decay of coarse salt grasses and other vegetation. On account of the extreme difficulty of access and the present low value of these lands, the soil survey is not carried on in great detail. Where the areas are large and have not been subjected to local stream depositions the character of the material is not subject to very much local change. The agricultural value of these lands is very low, depending mainly upon the pasturage afforded and the coarse hay that can with difficulty be harvested; and, on the other hand, they are a distinct menace to health, as they form the breeding-places of disease-carrying insects. Efforts to drain and reclaim these marshes have been attended with some success. The possibilities of successful reclamation depend upon the engineering problems connected with the keeping out of the tides and the subsequent efficient drainage of the land. A vast amount of such reclamation work has been done in Holland and some important, though relatively small, areas have been reclaimed in the United States.

Galveston coarse sand.—This type consists of medium to coarse sand 3 feet in depth, with an admixture of fine and coarse gravel and shell fragments. It occurs as a fringe along the coast and is of no agricultural value.

	1	2	3	4	5	6	7
Soil (1)	3	53	41	3	0	0	0

	Acres.
Everett, Wash	256
Island County, Wash	1,536

Galveston sand.—This is a light-gray to white sand 3 feet or more in depth, often containing a large percentage of fine particles of shell. It occurs as narrow ridges or islands along coasts. The surface varies from smooth beaches to dunes. It is generally unproductive and non-agricultural.

	1	2	3	4	5	6	7
Soil (1)	2	17	36	43	1	0	0
Subsoil (1)	0	7	37	37	2	0	0

	Acres.		Acres.
Dover, Del	64	Worcester County, Md	8,064
Long Island, N. Y	12,224	Yorktown, Va	1,984
Norfolk, Va	[a]10,752		

[a] This includes some Dunesand, but the whole area is of so little agricultural importance that the two types were not separated.

Galveston fine sand.—This is a light-gray to white loose, incoherent, siliceous fine sand 3 feet or more in depth, containing varying amounts of shell fragments. The type owes its formation to the action of waves and tides, and is modified by wind action at the higher elevations. It occurs as narrow strips and beaches along the seacoast. Where washed by the waves it presents a smooth, hard surface, but farther inland it rises in rather loose, irregular hillocks. It is not adapted to agricultural purposes.

	1	2	3	4	5	6	7
Soil (4)	0	2	8	86	4	0	0
Subsoil (2)	0	2	6	86	5	0	0

	Acres.
Brazoria, Tex.	[a]1,152
Charleston, S. C.	5,696
Rhode Island	2,048

Galveston sandy loam.—This consists of a surface mass of sandy loam and eel-grass turf about 12 inches deep, underlain by a gravelly sandy loam subsoil. It occupies shore lines and barrier beaches, and owes its origin to wind-blown sand, mixed with the finer materials of the coastal flats. Where diked and drained, it makes a productive soil much lighter and easier to cultivate than the Galveston clay. It is adapted to the same crops as the latter soil, and on account of the easier cultivation and the less compact nature of the material is rather more desirable as an agricultural soil. Very small areas have been reclaimed.

	1	2	3	4	5	6	7
Soil (2)	2	11	10	17	14	31	14
Subsoil (1)	3	11	7	19	20	33	8

	Acres.
Long Island, N. Y.	16,448
Rhode Island	4,224

Galveston clay.—The soil varies from a drab or yellow to black clay and rests on a subsoil of still heavier clay. Both soil and subsoil usually contain calcareous nodules. The type occurs as level, flat areas with poor drainage, representing the type of salt marsh extensively developed along the sea coasts. The native vegetation is almost entirely salt grass, affording a rather poor pasturage. The type needs to be diked and drained before reclamation is possible, but when so reclaimed and

[a] Mapped as Galveston sand.

the excess of salt removed it makes an exceedingly productive soil, especially for corn, cabbage, onions, rice, potatoes, and hay.

	1	2	3	4	5	6	7
Soil (13)	1	4	3	10	7	35	39
Subsoil (10)	1	3	3	8	8	37	38

	Acres.		Acres.
Brazoria, Tex	31,168	New Orleans, La	5,504
Charleston, S. C	77,312	San Jose, Cal	26,048
Dover, Del	30,784	Worcester County, Md	23,936
Long Island, N. Y	36,352	Yorktown, Va	21,568
Los Angeles, Cal	4,800		

HOUSTON SERIES.

The Houston series occurs principally in the black, calcareous prairie regions of Alabama, Mississippi, and Texas. The soils are characterized by a large percentage of lime, especially in the subsoil, which in some of the types consists of white, chalky limestone. The series has been derived from the weathering of calcareous clays, chalk beds, and "rotten" limestones, all of late Cretaceous age. In some localities remnants of later sandy and gravelly deposits have been mingled with the calcareous material, giving rise to the gravelly and loam members of the series. The soils of the Houston series are very productive. They are at present devoted chiefly to the growing of cotton and corn, but some of them will produce excellent and more profitable crops of alfalfa.

Houston gravelly clay.—The soil is a heavy, dark-brown to black clay loam or clay 12 inches deep, containing a large amount of gravel and rounded, waterworn pebbles, varying in size from one-eighth of an inch to 3 inches in diameter. The subsoil is a stiff clay of a light-brown color, becoming stiffer as the depth increases, and usually containing a small percentage of rounded gravel and pebbles, although there are small areas where it is a bed of porous gravel. The type occupies the higher ridges of the rolling prairie, and is easily eroded. The gravel is derived from the remains of an old formation, which has been almost entirely worn away, leaving only a thin layer capping the higher ridges. Owing to its topography and gravelly character the type has good drainage. The crops grown are cotton, corn, sorghum, oats, and some Kafir corn, and good yields are usually obtained.

	1	2	3	4	5	6	7
Soil (5)	1	2	3	7	11	40	36
Subsoil (5)	1	2	3	6	9	37	42

	Acres.
Austin, Tex	36,672
San Antonio, Tex	53,696
Waco, Tex	1,984

Houston loam.—The soil is a gray to light-brown loam, with an average depth of 10 inches, containing a considerable amount of silt. It is friable and when well cultivated has a desirable tilth. The subsoil is a drab to slate-colored silty clay, containing noticeable amounts of fine sand. It becomes heavier with depth, and at 36 inches is a stiff, plastic, silty clay, often slightly mottled and containing a small percentage of fine sand. Small rounded pebbles are sometimes encountered in both soil and subsoil. The type occupies slightly rolling upland prairies, and except in some depressed areas the drainage is good. The Houston loam occurs between the heavy black clay lands of the prairie and the sandy timber lands, and has been formed by the intermingling of the materials from these two classes of soils. It is best adapted to early maturing crops, as droughts of the late summer months seriously affect the yields. Good crops of cotton, corn, oats, and sorghum are produced.

	1	2	3	4	5	6	7
Soil (5)	0	1	2	14	12	49	21
Subsoil (5)	0	1	2	7	9	44	36

	Acres.
Paris, Tex	[a] 62,144
Waco, Tex	8,640

Houston black clay loam.—The soil is a heavy grayish-brown loam or clay loam from 8 to 15 inches deep. The subsoil has the same texture, but the color changes gradually from brownish-gray to yellowish at a depth of 4 or 5 feet. Often a few small rock fragments occur in both soil and subsoil, but where the development is typical the underlying rock is found at a great depth and fragments are absent. It is a residual type derived from the weathering of white limestone. The soil is friable and easily worked, and retains moisture well. The type occurs on the gently rolling prairies and has excellent drainage. This soil type is closely associated with the Houston black clay, but is not so stiff and waxy and is sometimes found in higher locations. It is a good

[a] Mapped as Houston silt loam and Houston clay.

soil for cotton, corn, and sorghum, and when irrigated is well adapted to truck farming and to such fruits as are suited to the climate.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	8	15	47	28
Subsoil (2)	1	1	1	11	16	38	32

	Acres.
San Antonio, Tex	54,272

Houston black clay.—The soil is a black or sometimes drab clay about 10 inches deep, friable when well cultivated, but becoming waxy and sticky when wet, and if not continually cultivated caking into a very hard and compact mass that cracks into irregular blocks on drying. The subsoil is a waxy, very stiff and tenacious clay of lighter color than the soil. Both soil and subsoil contain varying quantities of lime concretions. The type is derived from the weathering of soft limestone or calcareous clays, principally of Cretaceous age. The soil is very productive and is used commonly for corn, cotton, and rice, according to locality, elevation, and drainage, and is adapted also to grass.

	1	2	3	4	5	6	7
Soil (17)	0	1	1	7	8	43	40
Subsoil (17)	1	1	1	6	8	43	40

	Acres.		Acres.
Anderson County, Tex	[a]3,264	Paris, Tex	35,008
Austin, Tex	190,400	San Antonio, Tex	22,976
Brazoria, Tex	272,576	Sumter County, Ala	26,648
Houston County, Tex	3,200	Waco, Tex	57,280
Lavaca County, Tex	215,232	Willis, Tex	[b]20,480
Lee County, Tex	38,208		

Houston clay.—The soil is a gray to brown or black loamy clay 4 to 10 inches deep, resting on a stiff, lighter colored clay subsoil passing at about 20 inches into a light-gray or white rotten limestone or chalk. The color of the soil varies somewhat according to topographic position, the darker colored areas occupying the depressions and more level situations, while the white subsoil is often exposed along slopes, giving rise to irregular spots resembling "galls." The soil is friable and easily cultivated under proper moisture conditions, but is extremely plastic and sticky when wet. Areas not under cultivation bake and suncrack upon drying. The type occupies level to gently rolling country, usually prairie, and is derived from rotten limestone or chalks

[a] Mapped as Houston clay. [b] Mapped as San Jacinto clay.

of Cretaceous age. Cotton is the principal product, but the soil produces good yields of corn, oats, grass, and legumes.

	1	2	3	4	5	6	7
Soil (17)	1	2	2	9	11	41	32
Subsoil (15)	1	1	1	6	9	40	41

	Acres.		Acres.
Austin, Tex	[a]61,440	Russell, Kans	[c]35,456
Dallas County, Ala	149,184	San Antonio, Tex	[a]4,480
Macon County, Ala	[b]8,576	Sumter County, Ala	59,048
Montgomery County, Ala	86,400	Waco, Tex	12,864
Perry County, Ala	136,128		

LUFKIN SERIES.

The Lufkin series is characterized by gray surface soils and heavy, very impervious, plastic gray and mottled subsoils. The difference between the texture of the surface soil and that of the subsoil is very marked, especially in the sandy loam members. The tree growth is principally scrub oak. These soils are generally lower in agricultural value than those of the Norfolk and Orangeburg series.

Lufkin gravelly loam.—The soil is a gray fine sand. In depressed areas it is sometimes considerably heavier. The subsoil is a heavy sandy clay varying much in color. Both the soil and subsoil contain large quantities of gravel. The surface is generally rough and hilly and the drainage thorough. The type is largely in pasture. Yields of about one-third bale of cotton and 15 bushels of corn per acre are secured on some of the less gravelly areas.

	1	2	3	4	5	6	7
Soil (1)	0	0	1	37	41	12	9
Subsoil (1)	1	0	2	17	16	20	44

	Acres.
Lee County, Tex	47,360

Lufkin sand.—This type consists of a loose, incoherent gray to brown medium sand 12 inches in depth, underlain by a gray or yellow sand of the same texture. Beneath the sand at a depth of 2½ to 5 feet is found the same drab and yellow mottled sandy clay that forms the subsoil of the Lufkin sandy loam, the only distinction between the two types being the difference in the depth of sand overlying the clay

[a] Mapped as Austin clay.
[b] Mapped as Houston black clay.
[c] Mapped as Benton loam.

and the consequent difference in agricultural value. The soil readily absorbs water, and its location on ridges or in proximity to streams insures adequate drainage. The type is of sedimentary origin, and is derived from a Coastal Plain formation consisting of loose, incoherent sands. The soil is rather poor and crops grown upon it usually suffer from lack of moisture. It is well suited to sweet potatoes, and some early truck crops might also do well. It supports a forest growth of post oak, black-jack oak, and some live oak.

	1	2	3	4	5	6	7
Soil (2)	0	10	19	55	9	4	3
Subsoil (2)	0	9	20	54	9	5	3

	Acres.
Lavaca County, Tex	63,936

Lufkin fine sand. The soil is a gray fine loamy sand about 10 inches deep, resting on a subsoil of much the same character but occasionally more loamy. At a depth of from 3 to 5 feet occurs a gray or mottled stratified clay. The type is generally well drained, but occasionally small areas occur as depressions, where the drainage is deficient. Such areas are locally referred to as "crawfish land." The natural growth is scrub pine and oak. The soil produces fair yields of corn and cotton, but is rather better adapted to early truck crops and peaches. The soil needs green manuring for the incorporation of more organic matter.

	1	2	3	4	5	6	7
Soil (2)	1	1	1	25	47	22	3
Subsoil (3)	0	1	1	27	40	26	5

	Acres.
Houston County, Tex	184,384
Lufkin, Tex	39,680

Lufkin sandy loam. The soil is a gray to brown medium loamy sand or light sandy loam varying in depth from 8 to 20 inches. The subsoil consists of a drab and yellow mottled, tenacious, impervious, sandy clay, often streaked with iron stains. Iron and sometimes lime concretions in small quantities occur in both soil and subsoil, and thin beds of gravel are sometimes seen. The type is derived from the weathering of Gulf Coastal Plain deposits consisting of unconsolidated sands and clays. The topography is flat to rolling. The major part of the type has good drainage. Cotton and corn are the principal crops. Sorghum and Irish potatoes succeed well and truck crops are grown with success. The timber growth consists largely of post oak, with some black-jack oak, and along the streams live oak.

	1	2	3	4	5	6	7
Soil (2)	0	5	11	50	16	12	6
Subsoil (2)	0	3	8	32	10	12	35

	Acres.
Lavaca County, Tex	357,632

Lufkin fine sandy loam.[a]—This soil type consists of a gray or brown fine loamy sand or light sandy loam about 12 inches in depth, resting on a plastic, impervious mottled gray and yellow sandy clay subsoil. The surface is level to rolling, and drainage is generally well established. The type is derived from Coastal Plain deposits. The timber growth is chiefly scrub oak. Cotton and corn are the principal crops.

	1	2	3	4	5	6	7
Soil (2)	0	1	2	35	29	26	6
Subsoil (2)	0	1	1	23	26	24	25

	Acres.
Lee County, Tex	113,152

Lufkin loam.—The soil to a depth of from 3 to 10 inches consists of a loam, containing considerable organic matter and having a dark-gray color. The subsoil is a stiff, compact, dark-colored sandy clay. The surface of this type is flat, with a few areas gently rolling, and in general is poorly drained. The type is derived from the weathering of Lafayette deposits. Corn and cotton are the principal crops, of which the yields are good, from 25 to 35 bushels of corn and from one-fourth to three-fourths of a bale of cotton per acre being secured. The type is also adapted to truck and strawberries.

	1	2	3	4	5	6	7
Soil (1)	0	1	3	34	26	22	14
Subsoil (1)	0	0	2	26	16	17	38

	Acres.
Lee County, Tex	5,376

Lufkin clay.—The soil is a loam or silty loam from 3 to 8 inches deep, containing occasionally a few iron concretions. The subsoil is a stiff, impervious drab or mottled gray and yellow clay. At a depth of 3 to 5 feet the clay is often distinctly stratified. The surface is generally level and the drainage is poor. The natural growth is scrub

[a] See also Susquehanna fine sandy loam, page 71.

pine and small oaks. The soil is not well adapted to ordinary farm crops, and small yields of corn and cotton are obtained.

	1	2	3	4	5	6	7
Soil (11)	1	2	1	8	13	50	25
Subsoil (17)	1	1	2	7	10	34	46

	Acres.		Acres.
Anderson County, Tex	17,216	Ouachita Parish, La	64
Crystalsprings, Miss	448	Paris, Tex	61,696
Houston County, Tex	59,200	Sumter County, Ala	[a] 102,016
Lufkin, Tex	6,976	Woodville, Tex	4,416
Nacogdoches, Tex	5,120		

GADSEN SERIES.

The Gadsen series includes dark-gray soils found upon gentle slopes or undulations adjacent to streams and upon level or depressed areas in the uplands. Their formation is due largely to the peculiar topographic conditions resulting from the sinking of the limestones which underlie, in some of the areas, the materials from which the Norfolk and Orangeburg soils have been derived. They may be considered as colluvial soils formed by the creeping or washing of material from higher lying areas. The series is very incomplete, only the sand, sandy loam, and loam members having been encountered. They constitute valuable farming soils, so far as mapped.

Gadsden sand.—This type consists of a dark-gray sand 10 inches deep, underlain by a gray or brownish sand subsoil appearing lighter in texture and extending to a depth of more than 36 inches. The soil is of medium to fine texture, and there is usually a considerable admixture of organic matter. The type lies on gentle slopes or undulations adjacent to streams, and is mainly hammock lands supporting a growth of hardwood forest. It is very productive, and is one of the best soils for the Florida wrapper tobacco, but requires careful treatment to maintain the yields.

	1	2	3	4	5	6	7
Soil (6)	2	10	11	45	21	5	6
Subsoil (6)	2	9	11	45	20	5	6

	Acres.
Bainbridge, Ga	7,488
Gadsden, Fla	45,248
Leon County, Fla	2,112

[a] Mapped in part as Lufkin clay loam.

Gadsden sandy loam.—The soil is a brown sandy loam from 8 to 14 inches deep, underlain by a grayish-yellow or yellow sand or light sandy loam subsoil with a depth of 3 feet or more. The sand present is usually of medium grade, but occasionally the coarse sand content is considerable. The type occurs on slopes and in depressions, where it represents wash or creep from higher lying areas. The soil produces good crops of cotton and corn, and in the low-lying areas sugar cane does well. In favorable locations it is adapted to growing Sumatra wrappers under shade.

	1	2	3	4	5	6	7
Soil (3)	1	15	15	38	9	6	16
Subsoil (3)	1	14	17	39	8	5	16

	Acres.
Leon County, Fla	5,952

Gadsden loam.—This type consists of a dark yellowish-gray loam, rather light in character, from 8 to 18 inches deep, underlain by a yellowish-gray loam or clay loam subsoil of a somewhat heavier texture. The type occurs as moderately high bottoms and bluffs. It is locally known as hammock land, and supports a growth of hardwood timber. The soil is well drained and quite productive, and is adapted to cotton, corn, and fruit.

	1	2	3	4	5	6	7
Soil (1)	1	8	16	20	6	27	21
Subsoil (1)	1	6	13	15	5	28	32

	Acres.
McNeill, Miss	14,592

SUSQUEHANNA SERIES.

The Susquehanna series consists of gray and brown surface soils underlain by heavy, plastic, red mottled subsoils. Where the basal clays are exposed by erosion they show brilliant colorings, often arranged in large patches of alternating liver-color, red, and white. These clays constitute the oldest shore-line and marine deposits along the inland margin of the Coastal Plain. The soils are usually of low crop-producing capacity. The areas occupied by this series are chiefly covered with pitch pine, scrub oak, and other trees of little commercial importance. The clay is remarkably plastic, and is peculiarly well adapted to brick and tile making.

Susquehanna gravelly loam.—The soil is a grayish-brown sandy loam, medium to fine in texture, containing 40 to 60 per cent of rock fragments and gravel, mainly iron sandstone. At a depth of 6 to 15 inches it overlies a red, occasionally mottled, tenacious clay subsoil, which also contains sand, gravel, and stones. It is found as broken areas along streams and as hills. Tillage is difficult, but fair crops of cotton and corn can be grown with careful fertilization.

	1	2	3	4	5	6	7
Soil (3)	3	6	5	26	20	21	19
Subsoil (3)	3	4	3	14	9	19	45

	Acres.
Montgomery County, Ala	7,424
Raleigh to Newbern, N. C.	[a] 14,330

Susquehanna fine sandy loam.—The soil is a gray to brown fine sand or light fine sandy loam about 12 inches deep. The subsoil is a red or yellowish-red clay, usually stiff and plastic, and mottled, especially in the lower depths. Iron concretions are usually present in both soil and subsoil. The type has been derived principally from the underlying clays. The surface is characterized generally by a rolling or hilly topography, and erosion is sometimes quite pronounced. This soil is adapted to fruits and vegetables, potatoes and peaches doing exceptionally well. Cotton and corn give medium yields.

	1	2	3	4	5	6	7
Soil (8)	0	2	2	28	40	19	8
Subsoil (7)	0	0	1	11	23	20	44

	Acres.		Acres.
Austin, Tex	[b] 24,640	Houston County, Tex	32,128
De Soto Parish, La	110,336	Waco, Tex	24,512

Susquehanna clay loam.—The soil is a yellow or brown loam about 10 inches deep, underlain by a heavy mottled red clay subsoil identical with Susquehanna clay. The type occupies hills, slopes, and valleys, and is adapted to grain and grass crops. Considerable areas are yet in oak and pine forest.

	1	2	3	4	5	6	7
Soil (3)	2	2	2	8	28	45	13
Subsoil (2)	0	0	0	3	16	25	55

	Acres.
De Soto Parish, La	14,080
Prince George County, Md	16,850

[a] Mapped as Garner stony loam. [b] Mapped as Lufkin fine sandy loam.

Susquehanna clay.—The soil is a clay loam 6 inches deep, sometimes containing gravel, overlying a stiff, tenacious, red and mottled pipe-clay subsoil. The type occupies hills and rolling land on the inner border of the Coastal Plain region. The soil is very refractory and hard to cultivate, and at present has little agricultural value.

	1	2	3	4	5	6	7
Soil (8)	2	3	2	5	11	33	39
Subsoil (8)	0	1	1	4	8	30	54

	Acres.		Acres.
Cecil County, Md	11,000	Macon County, Ala	[a]32,000
Harford County, Md	4,890	Montgomery County, Ala	129,344
Houston County, Tex	50,816	Prince George County, Md	22,300

WICKHAM SERIES.

The soils of this series occur as river terraces in the higher part of the Coastal Plain, near its contact with the Piedmont Plateau. They are characterized by reddish or reddish-brown surface soils containing a higher percentage of organic matter than the Norfolk series, and usually overlie reddish, micaceous heavy sandy loam or loam subsoils which become coarser, looser, and more incoherent at about 30 inches. The soils generally have a level or gently undulating surface, are fairly well drained, possess a retentive subsoil, and have a relatively high agricultural value.

Wickham sand.—The soil is a dark-brown to yellowish-brown coarse sand from 16 to 26 inches deep, generally coarser in texture and lighter in color below 14 inches. The subsoil is a reddish-brown or yellowish incoherent sandy loam, which grades at from 28 to 40 inches into a coarse, gravelly material. The type occurs along the rivers, occupying level or slightly sloping terraces. The drainage is good and in some of the coarser phases it is excessive. The type is derived from Pleistocene deposits. General farm crops are the principal products grown, and fair yields are secured.

	1	2	3	4	5	6	7
Soil (4)	7	30	13	17	13	11	9
Subsoil (4)	6	28	13	19	13	10	11

	Acres.
Hanover County, Va	4,416

Wickham sandy loam.—The soil is a reddish-brown or brown loamy sand to light friable sandy loam ranging in depth from 10 to 26 inches.

[a] Mapped as Lufkin clay.

The subsoil is a reddish sandy loam or loam, sometimes containing mica and grading into a heavy sandy loam or sandy clay also containing mica. The type occupies terraces a part of which are overflowed. The surface is level or nearly so, but the drainage is fairly good. It is derived from Pleistocene deposits. This is a very desirable soil for general farm crops.

	1	2	3	4	5	6	7
Soil (4)	2	16	15	24	14	17	12
Subsoil (4)	2	13	14	21	11	16	23

	Acres.
Hanover County, Va	5,120

Wickham clay loam.—The soil consists of about 6 inches of pale-yellow or gray loam or very fine sandy loam, passing into a yellow clay loam which extends to a depth of 12 inches. The subsoil varies from a slightly friable to a stiff yellow, olive, or mottled clay, containing considerable fine sand and fine flakes of mica in its lower depths. The type occupies level or slightly rolling terraces and is generally well drained. It is derived from sediments of Pleistocene age. The soil is very productive, yielding in good seasons from 40 to 60 bushels of corn, from 15 to 30 bushels of wheat, 50 or more bushels of oats, and from 1 to 2 tons of hay per acre.

	1	2	3	4	5	6	7
Soil (2)	1	3	5	27	25	22	16
Subsoil (2)	0	1	3	16	22	24	34

	Acres.
Hanover County, Va	2,176

MISCELLANEOUS SOILS OF THE ATLANTIC AND GULF COASTAL PLAINS.

Travis gravelly loam.—The soil is a coarse sandy loam containing a large quantity of rounded gravel both on the surface and in the soil. This grades at a depth of 10 to 12 inches into a mass of coarse sand and rounded gravel cemented together by a stiff, sticky red clay. The soil is derived from material brought down by the river at an earlier period and deposited along its course. This material at the present time forms a series of terraces on each side of the stream. Many of the rounded pebbles are of quartz and granite. The location of the type, together with the open texture, allows water to seep rapidly through it, so that crops suffer severely from drought. On a few of the more level areas cotton, corn, and oats are grown, but the yields are small. The soil seems best adapted to melons and tree fruits. This type is valuable mainly for the heavy growth of post oak and black-jack oak covering a large part of it.

	1	2	3	4	5	6	7
Soil (5)	22	21	9	15	12	14	7
Subsoil (5)	14	16	9	11	6	10	34

	Acres.
Austin, Tex	13,312
Waco, Tex	12,416

Gainesville sand.—The Gainesville sand is a gray loamy sand 8 inches deep, containing much organic matter, and underlain by a brown loamy sand of looser structure. The subsoil varies in depth, but is usually underlain at less than 3 feet by a calcareous clay or by partly weathered limestone. Both soil and subsoil contain limestone fragments. This soil occupies high, rolling upland, and the drainage is good. The soil and subsoil retain moisture fairly well, but the type suffers seriously from drought. The characteristic vegetation is mixed forest of pine and hardwoods. The principal crop is Sea-Island cotton, for which the soil seems especially well adapted. Corn, oats, and peanuts are also crops successfully grown. Some areas are used for general farming and the raising of cattle and hogs.

	1	2	3	4	5	6	7
Soil (3)	1	12	25	45	12	3	1
Subsoil (3)	1	11	25	44	12	2	4

	Acres.
Gainesville, Fla	7,744

Leon sand.—From 6 to 10 inches the soil is a light-gray or white medium sand, occasionally containing sufficient organic matter to give it a dark-gray color. The subsoil is a compact medium white sand, usually saturated with water. The type has an almost level surface and is deficient in natural drainage. It is probably derived from marine deposits of sand. It supports a timber growth of longleaf pine, and an undergrowth of wire grass and dwarf palmetto. No areas under cultivation have been encountered.

	1	2	3	4	5	6	7
Soil (1)	1	18	18	37	20	5	2
Subsoil (1)	1	15	16	38	21	6	3

	Acres.
Leon County, Fla	61,376

Calcasieu fine sand.—This type consists of a fine sand or fine sandy loam 18 inches in depth, underlain by 10 inches of loam bearing some silt and sand, grading into mottled clays. The subsoil often carries iron concretions. The fine sand phase is a loose, incoherent gray or dark sand derived from the deposition of the coastal terrace. The fine sandy loam phase is a yellow sand or sandy loam occupying districts near rivers. The type is found in low ridges and pine regions and is adapted to truck and orchard crops.

	1	2	3	4	5	6	7
Soil (4)	0	0	0	20	36	32	9
Subsoil (3)	0	0	0	16	22	34	26

	Acres.
Lake Charles, La	13,970

Leon fine sand.—The soil is a light gray to white fine sand, underlain at about 12 inches by a white sand subsoil extending to a depth of 3 feet. The type has a nearly level surface, and owing to its wet and in some places swampy condition, is unfit for agricultural purposes. Longleaf pine is the principal growth on this soil. In origin, topography, and drainage conditions it is similar to the Leon sand, but the sand is much finer than in the latter type.

	1	2	3	4	5	6	7
Soil (1)	0	2	3	59	34	2	1
Subsoil (1)	0	2	3	58	44	2	7

	Acres.
Leon County, Fla	8,192

Amite sandy loam.—The soil to an average depth of about 10 inches varies from a brown or reddish-brown sandy loam to a loamy sand of the same color. The subsoil varies from a heavy red sandy loam to a sandy clay. The surface is gently rolling and the type is sometimes spoken of as "second bottom" or "hammock lands." It is sedimentary in origin. The soil is adapted to corn, cotton, oats, sweet and Irish potatoes, and sugar cane, and is also desirable for truck crops.

	1	2	3	4	5	6	7
Soil (2)	0	4	12	34	11	30	9
Subsoil (2)	0	2	9	25	8	35	21

	Acres.
Tangipahoa Parish, La	7,232

Collington sandy loam.—The soil is a loose, loamy brown sand from 9 to 20 inches deep, usually containing considerable coarse sand, and is underlain by a yellow or greenish-yellow sticky sandy loam or sandy clay subsoil. The type is derived from the weathering of green glauconite sand, and at 30 to 40 inches pure greensand occurs. The soil is very productive and is used for general farming, small fruits, nursery stock, truck, and tobacco.

	1	2	3	4	5	6	7
Soil (9)	1	9	18	38	11	13	10
Subsoil (9)	1	7	14	32	10	12	22

	Acres.
Prince George County, Md	23,260
Salem, N. J	4,170
Trenton, N. J	83,456

Warsaw sandy loam.—This soil consists of from 8 to 15 inches of fine sandy loam, and is underlain to a depth of 36 inches or more with a fine sandy clay subsoil brown to yellow in color. The soil is usually brown or light brown, tending toward a dark gray in the lower depressions, where the texture becomes rather more silty. The type occurs mainly as second bottom terraces, varying in width from one-fourth to 1 mile. The surface is usually flat, but the drainage is generally adequate. It is sufficiently elevated above the streams to be overflowed only in seasons of unusually high water. It is derived from Pleistocene deposits. The soil is naturally quite productive and well adapted to the staple crops and to many of the truck crops. On the more elevated areas small fruits and peaches do well. Cotton yields from one-half to three-fourths bale per acre and corn from 10 to 20 bushels.

	1	2	3	4	5	6	7
Soil (3)	0	2	3	38	21	25	11
Subsoil (3)	0	1	2	22	19	26	30

	Acres.
Sumter County, Ala	33,408

Calcasieu fine sandy loam.—This type consists of a compact gray fine sandy loam from 6 to 18 inches in depth, resting on a clay loam subsoil that grades into a black or yellow clay containing lime nodules and iron concretions. It occurs along streams in very gently rolling areas. It is a good truck soil and is also adapted to pears and berries.

	1	2	3	4	5	6	7
Soil (6)	0	0	1	14	39	36	10
Subsoil (6)	0	0	0	12	27	37	22

	Acres.
Brazoria, Tex	23,040
Lake Charles, La	5,500

Lake Charles fine sandy loam.—The soil is a dark-brown or black, changing sometimes to light-gray, heavy very fine sandy loam, 14 inches in depth. The subsoil is a loam which grades at 10 inches into a clay loam carrying some silt, which in turn is underlain by a mottled clay, often carrying iron or lime concretions. The type is found on the higher elevations and is marked by sand hummocks. It owes its texture to local erosion and admixture of sand from hummock areas, and was originally a coastal deposit. It is adapted to farm crops requiring light soils and medium drainage.

	1	2	3	4	5	6	7
Soil (12)	1	1	0	7	28	50	13
Subsoil (12)	0	1	0	6	21	46	24

	Acres.		Acres.
Acadia Parish, La	28,032	De Soto Parish, La	62,592
Brazoria, Tex	38,784	Lake Charles, La	53,300

Myatt fine sandy loam.—The soil is a gray sticky fine sandy loam to a depth of 10 inches. The subsoil is a drab or gray silty clay of a tough consistency, usually containing a large percentage of iron concretions. The drab clay is mottled with iron stains. The type occurs on lower hillsides and low-lying bottoms. The latter areas are subject to frequent overflow and drainage is poor. Very little of this soil has been encountered under cultivation. The natural growth is gum, cypress, and oak, the latter making some very fine timber. The crop yields are only moderate, although with proper drainage and good treatment it is believed this soil could be brought to a good state of productiveness.

	1	2	3	4	5	6	7
Soil (2)	1	3	7	33	12	37	7
Subsoil (2)	1	2	6	23	8	40	21

	Acres.
Ouachita Parish, La	8,064

Amite loam.—The soil is a brown or light-chocolate colored loam about 8 inches deep, underlain by a yellowish or reddish clay loam subsoil of uniform texture to a depth of 36 inches. The type is of alluvial origin and occupies the higher flood plains. It is a good corn soil, producing from 30 to 40 bushels per acre, and is also adapted to cotton, sugar cane and some truck crops.

	1	2	3	4	5	6	7
Soil (2)	0	1	2	16	8	50	23
Subsoil (2)	0	1	2	10	5	50	32

	Acres.
Tangipahoa Parish, La.	16,320

Calcasieu loam.—This type consists of a dark-brown, brownish-gray or gray, silty loam, 6 to 16 inches in depth, grading into a clay loam subsoil 8 inches deep, beneath which are mottled clays. The type owes its origin to coastal deposits and is found in poorly drained areas or depressions containing scattered sand mounds. It is an excellent rice soil.

	1	2	3	4	5	6	7
Soil (3)	0	0	0	3	19	60	14
Subsoil (4)	0	1	0	3	19	55	20

	Acres.
Lake Charles, La.	51,280

Hempstead loam.—The soil is a friable brown or black loam 8 inches deep, containing a small amount of white quartz gravel and locally becoming somewhat sandy. The subsoil, to a depth of 24 inches, consists of a heavy yellow or reddish loam, slightly gravelly, underlain by a bed of rounded quartz gravel embedded in a sandy loam matrix, all considerably stained with iron. The type generally occupies level areas and was originally prairie. The soil produces good crops of corn, potatoes, tomatoes, cabbage, rye, and grass. It is also a fair soil for late truck crops.

	1	2	3	4	5	6	7
Soil (5)	3	7	4	5	11	48	21
Subsoil (5)	3	8	5	5	13	46	20

	Acres.
Long Island, N. Y.	[a] 53,824

Lake Charles loam.—The soil is a dark-brown, black, or bluish-black loam, carrying a high percentage of organic material. At 14 inches a subsoil of clay loam appears, underlain by mottled clay. The type owes its origin to local swamp areas, into which fine loam has drifted.

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[a] Part of this was mapped as Hempstead gravelly loam. It should have been mapped as Hempstead loam with gravel symbol, and the gravelly phase described as such in the report.

It is a heavy soil, difficult to till, but when properly cultivated it makes an excellent rice land.

	1	2	3	4	5	6	7
Soil (5)	0	1	1	4	8	62	22
Subsoil (5)	1	1	1	3	9	57	27

	Acres.
Acadia Parish, La	4,608
Lake Charles, La	1,770

Leonardtown loam.[a]—The soil is a yellow silty loam [b] closely resembling loess, 9 inches deep, and is underlain by a red and mottled clay loam subsoil, with peculiar interlocking clay lenses and pockets of sand. The type occupies slightly rolling upland and is a good soil for general farming, wheat, and grass. Much of the area of this type is waste land or grown up in white oak and pine forests, and some of the more level areas need underdrainage. The soil is deficient in organic matter and lime.

	1	2	3	4	5	6	7
Soil (16)	1	2	3	7	12	58	15
Subsoil (15)	2	3	3	7	10	50	23

	Acres.		Acres.
Calvert County, Md	7,950	Prince George County, Md	[c] 49,480
Hanover County, Va	6,784	St. Mary County, Md	95,500
Mason County, Ky	320	Yorktown, Va	36,800

Acadia silt loam.—The soil is a white or light ash-gray loose silt loam from 16 to 30 inches deep, underlain by a silty clay subsoil of a mottled brown and yellow color. The type occurs in rolling areas, and very little of it is cultivated.

	1	2	3	4	5	6	7
Soil (2)	1	2	1	2	6	69	21
Subsoil (2)	0	1	1	2	3	63	31

	Acres.
Acadia Parish, La	89,280

Crowley silt loam.—The soil is a silt loam having an average depth of 10 inches. When wet the color is brown, but upon drying becomes an ash gray. This is usually underlain by a gray or mottled gray and yellow silt loam to a depth of from 16 to 30 inches. Below this depth

[a] See also Portsmouth silt loam p. 57.

[b] This soil is a true silt loam and should have been grouped with that class.

[c] Part of this was mapped as Leonardtown gravelly loam. It should have been mapped as Leonardtown loam with gravelly symbol and the gravelly phase described as such in the report.

is a mottled gray, yellow, and red heavy impervious silt clay. Both soil and subsoil contain iron and lime concretions. The type occurs as level or slightly rolling prairies and is one of the finest rice soils of southern Louisiana. During wet seasons water often stands over the surface, but when well drained the type is well adapted to cotton and oats.

	1	2	3	4	5	6	7
Soil (9)	1	1	0	1	8	71	17
Subsoil (6)	0	1	1	1	6	71	18
Lower subsoil (3)	0	1	0	2	5	60	31

	Acres.
Acadia Parish, La	244,160
Stuttgart, Ark	[a] 132,800

Hammond silt loam.—The soil is a silty or very fine sandy loam with an average depth of 15 inches. The surface has an ashy-gray color, which changes to a dark-gray or brown when wet. The gray color may continue the entire depth of the soil, but frequently changes to a yellowish color at 4 or 5 inches from the surface. The subsoil is a heavy silty clay of a yellowish color, with drab, brown, or red mottling. A few iron concretions are found. The type usually occupies level areas, and the drainage is generally poor. It is derived from the Port Hudson clays, is deficient in organic matter, and is not naturally a productive soil. It is fairly well suited to oats, crab-grass hay, sugar cane, and small truck. With heavy fertilization large yields of strawberries are secured. The principal forest growth is longleaf pine.

	1	2	3	4	5	6	7
Soil (2)	1	2	2	9	23	51	12
Subsoil (2)	0	1	1	9	18	43	28

	Acres.
Tangipahoa Parish, La	70,976

Landry silt loam.—The soil is a dark-brown silt loam 10 inches deep, underlain by a heavy brown clay subsoil grading into greenish-yellow or drab clays. The subsoil contains numerous lime and iron concretions and differs from that of the Crowley silt loam in being more friable, less plastic, and having a more noticeable silty texture. The soil is productive, but the surface is so rolling that irrigation is imprac-

[a] Mapped in part as Almyra silt loam and in part as Miami clay loam. The timbered part of the latter type should have been separated and correlated with the Acadia silt loam.

ticable, and rice culture is therefore impossible. It is fairly well adapted to cotton.

	1	2	3	4	5	6	7
Soil (3)	1	1	1	2	7	70	18
Subsoil (3)	1	1	0	1	4	71	22

	Acres.
Acadia Parish, La	37,696

Monroe silt loam.—The soil is a fine sandy or silty loam 10 inches in depth, underlain by a yellow or red silty clay subsoil, usually mottled with white or brown below 2 feet. The type occurs as low terraces or in hills of little elevation. The forest growth is oak and pine. Very little of the type has been cultivated, and that with very poor success. Cotton can hardly be made to yield one-half bale per acre, and corn proportionally less.

	1	2	3	4	5	6	7
Soil (4)	1	1	1	11	13	59	14
Subsoil (4)	0	1	1	11	13	51	23

	Acres.
Ouachita Parish, La	39,282
Tangipahoa Parish, La	196,864

Crockett clay loam.—This is a dark-brown or black clay loam from 12 to 18 inches deep, underlain by a mottled drab and red, and sometimes yellow, clay loam. Both soil and subsoil contain a small proportion of fine smooth gravel or iron concretions and, at a depth of several feet, occurs a brittle gray material having much the same texture as soft soapstone rock and being sometimes stratified. The surface of the type is gently rolling to level and fairly well drained. This soil was probably formed by the weathering of some calcareous material, perhaps an impure limestone. It is best suited to cotton, corn, grain, and grasses. Alfalfa also should do well.

	1	2	3	4	5	6	7
Soil (1)	1	2	1	12	20	37	26
Subsoil (1)	1	2	1	11	15	39	30

	Acres.
Houston County, Tex	5,312

Lacasine clay loam.—The soil is a heavy brown or black clay loam 20 inches deep, grading into mottled clay subsoil. The subsoil contains some silt, iron nodules, and sometimes lime concretions. The type is found in depressions in large swamp areas free from hummocks.

The soil is heavy, difficult to till, and poorly drained, but with lasting properties. This type has no agricultural importance.

	1	2	3	4	5	6	7
Soil (3)	0	0	1	7	16	54	18
Subsoil (3)	0	0	0	3	13	56	24

	Acres.
Lake Charles, La	3,470

San Antonio clay loam.—The soil is a brownish or chocolate-colored loam or clay loam, from 8 to 12 inches deep. As a rule, there is no definite line of demarcation between soil and subsoil, either as to texture or color. Below 12 inches and extending to about 24 inches the subsoil becomes lighter in color and usually somewhat heavier in texture; thence to a depth of 36 inches the color changes to reddish and the texture becomes lighter, the material usually grading into coarse limestone gravel. This soil is derived directly from a limestone belonging to the Upper Cretaceous, or from limestone material reworked by ancient floods. The greater part of this type is under cultivation. It is very productive. Where irrigated, it is excellent for such fruit as is suited to the climate. The soil is adapted to cotton, corn, and hay, while sorghum and alfalfa are grown with a fair degree of success.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	9	17	45	27
Subsoil (3)	1	1	1	8	15	45	29

	Acres.
San Antonio area, Tex	28,608

Alloway clay.[a]—The soil is a red or gray clay loam 6 inches deep, containing some gravel, underlain by a mottled yellow and gray sticky clay subsoil to a depth of 3 feet or more. The type occupies rolling upland or bottoms, and is derived from recent sediments of Miocene or Glacial material. It is a good grass and wheat soil and produces fine apples. The soil is difficult to till and is generally in need of underdrainage.

	1	2	3	4	5	6	7
Soil (3)	2	7	6	8	5	48	21
Subsoil (3)	1	5	5	7	8	40	32

	Acres
Salem, N. J	10,580
Trenton, N. J	11,904

[a] See also Dunkirk clay, p. 154.

Mobile clay.—The soil consists of a yellow loam, with an average depth of 8 inches, resting on a stiff, plastic yellow clay or sandy clay subsoil extending to a depth of 3 or more feet. The soil is characterized by the presence of many iron concretions, and is usually found overlying the materials forming the Orangeburg sandy loam. The surface is flat and marked by many swampy, pondlike depressions covered by a scrubby growth of gum. The drainage is generally poor. The soil is best adapted to grain and grass.

	1	2	3	4	5	6	7
Soil (2)	1	3	7	20	28	23	18
Subsoil (2)	0	3	6	17	23	27	26

	Acres.
Mobile, Ala	896

Morse clay.—This type consists of a heavy silt or clay loam 6 to 8 inches deep, underlain by a heavy mottled clay subsoil, both soil and subsoil being quite calcareous. The type occurs along stream courses and generally has good drainage. It is a very unimportant soil, difficult to till, and little of it is under cultivation. It is adapted to rice where irrigation is possible, and in the well-drained areas is fairly well adapted to corn and cotton.

	1	2	3	4	5	6	7
Soil (1)	1	1	1	2	3	53	41
Subsoil (1)	1	1	0	1	3	41	54

	Acres.
Acadia Parish, La	1,664

Suffield clay.—The soil is a clay loam 12 inches deep, underlain by a close-textured, laminated clay subsoil The type owes its origin to lacustrine deposits. It occupies very poorly drained, level areas in the Connecticut Valley. On account of its poorly drained condition and close structure the soil is not adapted at present to any agricultural purposes, although used to some extent for pasturage.

	1	2	3	4	5	6	7
Soil (1)	1	3	3	21	18	30	24
Subsoil (1)	0	1	1	9	8	35	45

	Acres.
Connecticut Valley, Conn. and Mass.	23,610

SOILS OF THE FLOOD PLAINS OF THE MISSISSIPPI AND OTHER RIVERS.

An extensive and characteristic group of soils, usually known as "bottom lands," is found in the flood plains of numerous streams in the Mississippi Valley and Coastal Plain. The largest development of this group occurs along the Mississippi River, where the bottoms are often many miles in width.

The soils have been formed by deposition from stream waters during periods of overflow. The texture of the material depends upon the velocity of the current at the time of deposition. Where the current is very rapid, large stones and bowlders are borne along and beds of gravel and sand are formed. Along the swift-flowing streams the texture of the soil changes often within short distances, but in the wide bottoms large areas of very uniform soils are often formed. The soil material has usually been derived from various kinds of rocks, but in some instances is closely related to the surrounding geological formation. The red soils along the Red and other rivers in the Southwest have been formed by the reworking of the Permian Red Beds. In general, the soils along the streams which flow through the prairie region have a darker color than those along the streams which run only through the timbered sections of the country.

The difference in the origin, drainage, color, and organic matter content has given rise to three series of alluvial soils in the humid portion of the United States, which have been named the Wabash, Waverly, and Miller series.

WABASH SERIES.

The Wabash series comprises the most important of the alluvial types of soil. It embraces those soils having a dark-brown to black color and a large percentage of organic matter. These soils are typical of the Mississippi River, but there is no sharp distinction between them and other bottom soils found along the rivers of the Middle West. They are among the strongest and most productive soils in the country.

Wabash sandy loam.—The soil to a depth of from 12 to 24 inches consists of a dark-brown to reddish-brown sandy loam of rather coarse texture, becoming lighter in color with depth. This is underlain by a yellowish coarse sandy loam, coarse sand, or stratified gravel. Generally considerable gravel is distributed throughout the soil profile. The type occupies strips along river and stream bottoms and is generally subject to overflow. It is usually well drained. The principal crop is corn. The soil is also well suited to melons, sweet potatoes, cabbage, and other truck crops.

	1	2	3	4	5	6	7
Soil (3)	2	13	21	27	17	12	7
Subsoil (2)	2	13	17	32	15	13	8

	Acres.
Montgomery County, Ohio	[a] 4,000
Tippecanoe County, Ind	2,624

Wabash fine sandy loam.—The soil consists of a light-brown to black fine sandy loam about 12 inches deep. The subsoil varies from a fine sandy loam to a fine sand, which is generally dark colored, though sometimes passing into a yellow material at about 24 inches. Frequently considerable fine rounded gravel is distributed throughout the subsoil. The type is alluvial, and occupies flat bottom lands. Some areas produce heavy yields of wheat, oats, and corn, while others are better suited to melons, sugar beets, Irish potatoes, and alfalfa.

	1	2	3	4	5	6	7
Soil (2)	0	1	8	38	22	21	10
Subsoil (2)	0	1	8	37	24	20	10

	Acres.
Posey County, Ind	[a] 3,584
Stanton, Nebr	[b] 22,144
Tippecanoe County, Ind	11,712

Wabash loam.—Owing to its wide distribution and its alluvial origin from the wash of soils of different texture, the local characteristics of this type show considerable variation. It is generally a brown loam about 10 inches deep, often containing a small proportion of sand, and in local areas some gravel. The subsoil is usually a heavy brownish-yellow loam 20 to 40 inches deep, overlying a gravelly loam. It occurs as first bottoms along rivers and small streams, and much of it is subject to periodical overflow. It is a first-class corn soil, producing from 35 to 60 bushels per acre. More extensive use should be made of this type for canning crops, such as sugar corn, green peas, tomatoes, etc.

[a] Mapped as Miami sandy loam.

[b] Mapped as Arkansas fine sandy loam.

	1	2	3	4	5	6	7
Soil (21)	1	3	3	12	20	44	17
Subsoil (30)	1	3	3	11	17	42	22

	Acres.		Acres.
Auburn, N. Y	[a] 5,696	Marshall, Minn	[a] 3,968
Bigflats, N. Y	[b] 5,632	Montgomery County, Ohio	[a] 14,000
Binghamton, N. Y	9,280	Pontiac, Mich	[a] 1,152
Carrington, N. Dak	1,536	Portage County, Wis	2,944
Cleveland, Ohio	14,080	Syracuse, N. Y	[a] 9,728
Columbus, Ohio	[a] 26,880	Tazewell County, Ill	[c] 29,056
Coshocton, Ohio	[a] 17,600	Toledo, Ohio	[a] 5,504
Fargo, N. Dak	[a] 11,968	Tompkins County, N. Y	4,352
Grand Forks, N. Dak	[a] 17,728	Viroqua, Wis	[a] 23,552
Lyons, N. Y	[a] 5,184	Westerville, Ohio	[a] 17,856

Wabash silt loam.—The soil consists of a dark-brown to black silt loam about 12 inches deep, underlain by a heavy silt loam of lighter color. Sometimes, however, the dark color extends to a depth of 3 feet or more. The type is of alluvial origin, occupying stream bottoms subject to overflow, and is often poorly drained. When well drained it is a good soil, producing heavy crops of corn and grass and fair yields of small grain.

	1	2	3	4	5	6	7
Soil (41)	0	1	1	5	7	65	21
Subsoil (40)	0	1	1	4	6	64	24

	Acres.		Acres.
Brown County, Kans	[d] 29,952	Pikeville, Tenn	[e] 1,280
Clarksville, Tenn	[e] 17,090	Posey County, Ind	[h] 16,384
Clinton County, Ill	[f] 24,576	Russell, Kans	[j] 12,864
Crawford County, Mo	42,112	Saline County, Mo	[e] 5,440
Davidson County, Tenn	[e] 12,864	Sangamon County, Ill	[f] 40,192
Dubuque, Iowa	[g] 22,272	Sarpy County, Mo	18,496
Fort Payne, Ala	[e] 4,992	Scotland County, Mo	46,016
Howell County, Mo	[e] 48,512	Stanton, Nebr	[i] 25,152
Knox County, Ill	[f] 29,148	St. Clair County, Ill	[f] 9,664
Lauderdale County, Ala	[e] 44,800	Tama County, Iowa	[f] 70,592
Lawrence County, Tenn	[e] 7,616	Tippecanoe County, Ind	9,408
Madison County, Ky	12,672	Union County, Ky	[h] 25,216
McLean County, Ill	[f] 20,352	Warren County, Ky	[e] 7,552
Montgomery County, Tenn	[e] 17,090	Webster County, Mo	[e] 17,600
Newton County, Ind	[f] 832		

[a] Mapped as Miami loam.

[b] Mapped as Elmira fine sandy loam.

[c] Mapped as Lintonia loam. Part of this should have been mapped as Wabash silt loam.

[d] Mapped as Yazoo silt loam.

[e] Mapped as Clarksville loam.

[f] Mapped as Kaskaskia loam.

[g] Mapped as Lintonia loam.

[h] Mapped as Waverly silt loam.

[i] Mapped as Elkhorn silt loam.

[j] Mapped as Waldo loam.

Wabash clay.—The soil is a drab to black heavy clay loam 6 inches deep, containing considerable organic matter. The soil suncracks badly, frequently forming small aggregates which cause a close resemblance to "buckshot land." The subsoil is a drab or gray clay, sometimes resting upon fine sand at a depth of about 5 feet. The type occupies low areas to the rear of front lands and higher ridges in open forest lands in river deltas. It would usually be improved by drainage. In the northern areas the soil is adapted to corn; in the southern areas it is the finest cotton soil, yielding about $1\frac{1}{4}$ bales per acre.

	1	2	3	4	5	6	7
Soil (41)	0	1	1	3	7	49	37
Subsoil (41)	0	0	1	3	18	48	40

	Acres.		Acres.
Allen County, Kans	[a] 5,299	Parsons, Kans	[c] 31,808
Anderson County, Tex	[b] 47,872	Saline County, Mo	[b] 28,544
Austin, Tex	[b] 11,840	Sarpy County, Nebr	3,648
Brazoria, Tex	[b] 9,152	Scotland County, Mo	4,672
Carrington, N. Dak	3,328	St. Clair County, Ill	[b] 26,994
Clinton County, Ill	[b] 5,376	Smedes, Miss	[b] 37,760
East Baton Rouge Parish, La	[b] 13,824	Tangipahoa Parish, La	[b] 8,896
Houston County, Tex	48,768	Tazewell County, Ill	[b] 13,696
Johnson County, Ill	[b] 1,664	Waco, Tex	[b] 7,488
Montgomery County, Ala	[b] 50,624	Wooster, Ohio	[b] 1,216
New Orleans, La	[b] 18,368	Yazoo, Miss	[b] 45,080
O'Fallon, Mo	[b] 31,936		

Wabash heavy clay.—The soil is a dark-drab to black heavy clay, underlain at about 10 inches by a slightly lighter colored but stiffer and more tenacious clay, which generally becomes heavier with depth. If cultivated too wet the soil clods so as to interfere seriously with cultivation. Areas not under cultivation often bake and suncrack. The surface is level, with occasional swales and slight depressions. The type is alluvial in origin. The soil is very productive, giving large yields of cotton, corn, oats, and forage crops. Spring overflows make wheat rather an uncertain crop.

	1	2	3	4	5	6	7
Soil (2)	0	2	1	5	6	34	52
Subsoil (2)	0	0	1	4	9	39	47

	Acres.
Waco, Tex	[d] 13,248

[a] Mapped in part as Yazoo clay and in part as Sharkey clay.
[b] Mapped as Yazoo clay.
[c] Mapped as Sharkey clay.
[d] Mapped as Yazoo heavy clay.

WAVERLY SERIES.

The Waverly series is characterized by light-colored surface soils with drab, gray, and mottled yellow or white subsoils. The soils of this series occur almost entirely along the streams east of the Mississippi River. They are not as productive as the soils of the Wabash series.

Waverly fine sandy loam.—The soil to a depth of 15 inches is a light-brown to gray fine sandy loam, the sand content being usually large and of the finer grades. The soil becomes heavier as the depth increases, and at from 15 to 20 inches grades into a brown fine sandy loam with a larger percentage of silt and clay. The sand content, depth of soil, and size of the sand particles often vary according to location. The type generally occurs as a sandy ridge along streams. Its elevation above the stream assures good drainage. The soil is alluvial in origin, is productive and easily cultivated, and in seasons of average rainfall the crop yields are large. The type is best adapted to corn, melons, early vegetables, and alfalfa. The other crops successfully grown are wheat, oats, potatoes, and tobacco.

	1	2	3	4	5	6	7
Soil (6)	0	0	2	28	31	27	11
Subsoil (6)	0	0	3	31	28	25	12

	Acres.		Acres.
Boonville, Ind	3,904	Posey County, Ind	[a] 3,456
Clay County, Ill	[b] 1,344	Union County, Ky	[a] 3,072
Crystalsprings, Miss	3,840		

Waverly loam.—The soil is a brown loam about 10 inches deep, underlain by a brown to yellowish clay loam or a clay. The type occurs as first-bottom land along rivers and creeks. The surface as a rule is flat, though occasionally it may be slightly rolling. Open ditches are frequently necessary to provide adequate drainage. The type is alluvial in origin. The original timber growth consists mainly of gum, sycamore, water oak, beech, and willow. The soil is adapted to corn, wheat, and cotton, as well as to forage crops, according to location, and large yields are secured when no injury is sustained by overflows.

	1	2	3	4	5	6	7
Soil (5)	0	2	3	13	16	48	17
Subsoil (5)	0	3	4	12	14	39	27

	Acres.
Henderson County, Tenn	47,360
Posey County, Ind	[c] 8,320
Sumter County, Ala	100,288

[a] Mapped as Miami fine sandy loam.
[b] Mapped as Yazoo sandy loam.
[c] Mapped as Yazoo loam.

Waverly silt loam.[a]—The soil is a light-brown to white silty loam about 10 inches in depth and is underlain by a grayish or yellowish silty loam of closer structure. The type occupies bottom lands and marshy depressions, and owes its origin to sediments washed from adjoining silty uplands. Corn is the principal crop grown on this soil.

	1	2	3	4	5	6	7
Soil (23)	0	1	1	3	8	71	16
Subsoil (23)	0	1	1	3	6	70	19

	Acres.		Acres.
Boonville, Ind	17,280	McCracken County, Ky	5,824
Clay County, Ill	30,976	O'Fallon, Mo	57,088
Clinton County, Ill	42,112	St. Clair County, Ill	25,152
Crystalsprings, Miss	25,088	Scott County, Ind	20,160
Johnson County, Ill	31,936		

Waverly clay loam.—The soil to a depth of about 6 inches is a heavy light-brown to grayish silt loam, often containing small iron concretions scattered over the surface and through the soil. The soil becomes heavier with depth and grades into a very heavy silt loam containing a large percentage of clay. At a depth of from 12 to 20 inches the subsoil is a sticky, mottled clay, usually containing small iron concretions, becoming stiffer and more tenacious as the depth increases. There is apparently little organic matter in the soil except in swampy areas. The compact nature of the soil, together with its level topography and low-lying position, often makes drainage very difficult. This type is alluvial in origin, having been formed largely by the reworking by stream action of the loessial material from the uplands. The soil seems best adapted to clover, timothy, and redtop. The other crops grown are tobacco, wheat, and corn, the yields depending on thoroughness of drainage and cultivation. Where no drainage is practiced the land is either covered with a growth of scrub oak or used exclusively for for pasture.

	1	2	3	4	5	6	7
Soil (5)	1	2	1	3	6	56	30
Subsoil (5)	1	1	1	3	4	50	40

	Acres
Boonville, Ind	30,208
O'Fallon, Mo	23,424
Posey County, Ind	[b] 14,592

[a] See also Wabash silt loam, p. 86.

[b] Mapped as Guthrie clay.

Waverly clay.—The soil consists of a light-brown clay loam about 10 inches deep. The percentage of clay and silt is high, and the soil rapidly becomes stiffer and more tenacious with depth, grading into a heavy, tenacious clay subsoil of a brown or drab color which is often mottled in the lower depressions. A few small iron concretions are frequently seen, both in the soil and the subsoil, especially in the more swampy areas. The type occupies low bottom lands, is alluvial in origin, and subject to overflow. The occasional addition of new material to the soil tends to maintain its productiveness. This soil is best adapted to corn, and when well drained and cultivated it yields as much as 60 bushels per acre. Wheat, when not damaged or destroyed by floods, does well, and also oats and tobacco. Clover, timothy, and other grasses give large yields.

	1	2	3	4	5	6	7
Soil (9)	0	1	0	1	5	58	35
Subsoil (9)	0	0	1	1	7	54	36

	Acres.		Acres.
Boonville, Ind	8,320	Union County, Ky	[b] 28,480
McCracken County, Ky	9,536	Wooster, Ohio	25,408
Posey County, Ind	[a] 30,720	Huntsville, Ala	[c] 11,840

MILLER SERIES.

The soils of the Miller series are distinguished from those of the Wabash and Waverly series by their reddish color. They occur along the Red and other rivers that flow through the Permian Red Beds and represent this material reworked by streams. As these streams flow away from the areas covered by the red beds, material from the surrounding country is added, so the soils gradually lose their red color and change to the Wabash or Waverly series. These are productive soils, but are not so desirable as those of the Wabash series.

Miller fine sand.—The soil consists of a loose, loamy gray to reddish-gray fine sand, resting on a loose fine sand extending to a depth of several feet. It is a river valley soil, alluvial in origin and usually well drained. It is used principally for corn and cotton, and fair yields are received. The higher lying areas are well adapted to fruit, especially peaches. Vegetables also do well, but are grown only for home consumption.

[a] Mapped as Yazoo clay.

[b] Mapped in part as Yazoo clay and in part as Sharkey clay.

[c] Mapped as Clarksville clay.

	1	2	3	4	5	6	7
Soil (4)	0	1	6	45	35	9	3
Subsoil (4)	0	1	3	28	53	11	4

	Acres.
Miller County, Ark	34,688
Paris, Tex	[a] 13,312
Waco, Tex	1,408

Miller fine sandy loam.—The soil consists of a brown or grayish-brown fine to very fine sandy loam from 12 to 24 inches deep, underlain by a heavy fine red sandy loam or sandy clay. In local areas the soil may extend to a depth of 3 feet. This is an alluvial type formed by the reworking of the Permian Red Beds and occurs as terraces along streams. The higher areas are seldom if ever overflowed. The type is well drained, except in small local areas. It is a good soil for corn and cotton and is also well adapted to truck and fruits.

	1	2	3	4	5	6	7
Soil (7)	1	1	2	15	46	23	9
Subsoil (4)	1	1	3	15	30	24	25

	Acres.
Miller County, Ark	28,544
Ouachita Parish, La	[b] 86,272
Waco, Tex	22,208

Miller silt loam.—The surface soil consists of a brown, red, or light-chocolate colored silty loam, varying in depth from 6 to 20 inches. The subsoil is a heavy red silt loam, often grading into a lighter-colored fine sandy loam at about 2 to 3 feet. This is an alluvial soil occupying level or slightly rolling areas and is frequently subject to overflow. It is a friable, productive, and easily cultivated soil, and is usually naturally well drained. It is adapted to cotton, corn, alfalfa, and sugar cane, and also to late vegetable and truck crops. The timber growth is cottonwood, ash, hickory, red oak, and sweet gum.

	1	2	3	4	5	6	7
Soil (7)	0	1	1	2	11	71	15
Subsoil (8)	0	0	1	3	13	64	19

	Acres.		Acres.
De Soto Parish, La	5,248	Vernon, Tex	[d] 2,880
Paris, Tex	[c] 8,512	Waco, Tex	960

[a] Mapped as Vernon fine sand but now recognized as belonging in the Miller series.

[b] Mapped as Monroe fine sandy loam.

[c] Mapped as Orangeburg silt loam, but now recognized as belonging in the Miller series.

[d] Mapped as Vernon silt loam, but now recognized as belonging in the Miller series.

Miller clay.—The soil to a depth of 10 inches is a brownish-red or chocolate-colored clay, underlain by a stiff, tenacious brown or red clay subsoil. In some cases a yellow fine sandy loam is found at a depth of 3 feet, while in depressed areas subject to frequent and long-continued overflows a drab or blue clay may form the deeper subsoil. This soil represents the finest materials brought down by streams from the Permian Red Beds and deposited during overflows. It is a strong soil for corn, cotton, and sugar cane, and where well drained large yields are secured. The timbered areas support a heavy growth of oak, gum, whitewood, and cypress, with a dense undergrowth of shrubs, vines, and briers.

	1	2	3	4	5	6	7
Soil (4)	0	1	2	1	1	33	62
Subsoil (4)	0	1	1	1	1	33	63

	Acres.
De Soto Parish, La	9,152
Waco, Tex	[a] 4,608
Miller County, Ark	[b] 110,656

MISCELLANEOUS SOILS OF THE FLOOD PLAINS OF THE MISSISSIPPI AND OTHER RIVERS.

Yazoo sandy loam.[c]—The soil is a gray to brown fine sandy loam 6 to 12 inches deep, underlain by a lighter colored fine sandy loam. It has been deposited by streams, usually upon a clay foundation, which in some cases comes to within 12 inches of the surface. The type occupies low flat ridges, forming front lands near stream courses in river bottoms. The chief product is cotton, but the soil is suited to truck and market garden crops. Corn and truck do well in the northern areas.

	1	2	3	4	5	6	7
Soil (24)	0	2	2	10	27	49	9
Subsoil (25)	0	1	1	7	23	56	12

	Acres.		Acres.
Anderson County, Tex	1,600	New Orleans, La	41,600
Allen County, Kans	909	Posey County, Ind	2,752
Austin, Tex	30,336	St. Clair County, Ill	12,800
Brazoria, Tex	31,872	Smedes, Miss	8,512
Clinton County, Ill	2,176	Tazewell County, Ill	128
East Baton Rouge Parish, La	1,536	Yazoo, Miss	26,670
Houston County, Tex	2,688		

[a] Mapped as Miller heavy clay.
[b] Mapped as Sharkey clay.
[c] See also Waverly fine sandy loam, p. 88.

Austin fine sandy loam.—The soil is a brownish-yellow or reddish-gray fine sandy loam. There is no marked difference between the soil and subsoil, and the latter often extends to a depth of about 40 feet without change. From the surface to a depth of about 3 feet the color gradually becomes lighter. This soil is of sedimentary origin, having been formed by the overflow of the streams when their channels stood at a higher level. It occurs in very level areas, with an elevation of from 40 to 60 feet above the present level of the streams. is well drained, and is inclined to be somewhat droughty. It is adapted to corn, cotton, fruit, and some vegetables. Considerable sorghum fodder is grown upon the first-bottom areas, and alfalfa would also do well here.

	1	2	3	4	5	6	7
Soil (1)	0	1	2	33	24	26	14
Subsoil (1)	0	1	2	29	23	31	15

	Acres.
San Antonio area, Tex.........	21,440

Chattooga loam.—The soil consists of a yellowish-brown to gray sandy loam grading into a loam at about 10 inches. A heavier phase of the type occurs in the low-lying areas. The sand varies in texture from medium to fine. The subsoil contains sufficient clay to make it a heavy coherent loam. The type occurs as a bottom or river terrace soil, and is subject to occasional overflow. The soil is derived in part from the weathering of shale and in part as alluvial material from the same source. It is fairly productive for corn.

	1	2	3	4	5	6	7
Soil (2)	0	2	3	27	19	35	14
Subsoil (2)	0	1	3	18	11	39	28

	Acres.
Fort Payne, Ala................	5,696

Congaree loam.—The soil is a brownish fine sandy loam to medium heavy loam from 4 to 8 inches deep. The subsoil is a gray or brown mottled plastic clay, carrying considerable fine sand. Occasionally the soil in small areas is deeper and lighter in texture. This is an alluvial soil occupying flood plains of creeks and smaller streams, generally containing considerable organic matter, and is subject to overflow. It is a good cotton and corn soil and when properly drained is adapted to a wide variety of crops.

	1	2	3	4	5	6	7
Soil (2)	0	6	8	54	13	12	7
Subsoil (2)	0	0	2	38	17	21	22

	Acres.
Montgomery County, Ala	33,856

Jackson loam.—The soil is a light-brown loam with an average depth of 14 inches, and grades into a mottled sandy clay or clay subsoil. The type occurs as second bottom, with a gently rolling surface, and is alluvial in origin. The soil produces about 15 bushels of wheat and from 25 to 40 bushels of corn per acre. Onions give large yields. The soil is well adapted to light farm crops and to truck, wrapper tobacco, and peaches.

	1	2	3	4	5	6	7
Soil (2)	0	1	0	12	26	49	12
Subsoil (2)	0	1	1	17	24	44	13

	Acres.
Shelby County, Mo	2,304

Lintonia loam.[a]—The soil consists of a brown silty loam [b] 10 inches deep. The subsoil is a yellow silt, quite uniform in color and texture, sometimes underlain by clay at a depth of from 3 to 4 feet. The soil lacks plasticity, and has rather a mealy character. The type is found along the foot of bluffs and as narrow strips in stream valleys, generally adjacent to the higher lying Memphis silt loam. The soil is mainly colluvial in origin, representing reworked material of the Memphis silt loam. It is rarely inundated, but is subject to addition of material from uplands during winter rains. This is a good cotton soil and is also well adapted to market gardening and fruit culture. In the northern areas it produces corn, wheat, oats, hay, and potatoes.

	1	2	3	4	5	6	7
Soil (6)	0	0	1	2	8	81	7
Subsoil (6)	0	0	1	3	10	77	9

	Acres.		Acres.
Posey County, Ind	[c] 9,408	Union County, Ky	[c] 17,984
Smedes, Miss	10,368	Yazoo, Miss	3,060
St. Clair County, Ill	5,696		

Sanders loam.—The soil is a dark-brown, reddish-brown, or gray loam. The subsoil is lighter in color and apparently heavier in tex-

[a] See also Wabash loam, p. 85, and Wabash silt loam, p. 86.

[b] This soil is a true silt loam and should have been grouped with that class.

[c] Mapped as Memphis silt loam.

ture. The type occurs as narrow strips along the creeks, extending up the edge of the valleys, and frequently has Sharkey clay on the stream side, which interferes with proper drainage. It is considered a very good corn soil, producing as much as 45 bushels per acre where well drained. It is not considered so good for cotton, producing about one-half bale per acre. The soil generally is in need of drainage.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	14	20	44	19
Subsoil (3)	0	1	2	22	35	33	18

	Acres.
Paris Tex	10,112

Yazoo loam.[a]—The soil consists of a yellow or brown loam or silt loam from 0 to 6 inches deep. The subsoil is usually a silt loam, but in local areas may be a silty clay or fine sandy loam. The type occupies low ridges in river bottoms, and represents the higher-lying areas of fine sediment deposited by inundations. It is a strong cotton soil, producing 1 bale per acre. In northern areas the soil is adapted to corn and wheat.

	1	2	3	4	5	6	7
Soil (16)	0	0	1	2	17	65	15
Subsoil (15)	0	0	0	2	12	62	23

	Acres		Acres.
Allen County Kans	20,531	Parsons, Kans	28,352
Clay County, Ill	1,472	Saline County Mo	15,680
East Baton Rouge Parish, La	1,472	St Clair County, Ill	4,160
Houston County Tex	25,280	Smedes, Miss	20,288
New Orleans, La	18,112	Yazoo, Miss	16,080
O'Fallon, Mo	16,640		

Neosho silt loam.—The soil to a depth of 8 inches is a light-colored, somewhat ashy silt loam containing small and varying amounts of fine and very fine sand. The subsoil from 8 to 25 inches is a drab very compact and impervious silty clay locally known as "hardpan." The type occurs principally upon terraces lying from 5 to 15 feet above the level of the river bottom. Its elevation is sufficient to insure it against overflows and to afford fair surface drainage. Deep plowing or subsoiling and the addition of organic matter would greatly improve its moisture-holding capacity. The soil is largely an old alluvial deposit, greatly influenced by wash from the adjoining

[a] See also Waverly loam, p. 88.

uplands. It is probably best adapted to wheat and grass, but corn and oats do well when the season is not extremely wet or dry.

	1	2	3	4	5	6	7
Soil (5)	0	1	1	3	11	69	15
Subsoil (5)	0	1	2	4	8	63	22

	Acres.
Allen County, Kans	9,171
Parsons, Kans	[a] 21,568

Carrington clay loam.—The soil to a depth of 10 inches consists of a brownish-yellow silty clay, and is underlain by a subsoil ranging from material of the same texture and color as the soil to a stiff tenacious dark-gray clay. At a depth of from 3 to 5 feet a stratum of reddish-yellow sand containing varying quantities of calcium carbonate, gypsum, and iron sulphate is frequently encountered. Where the areas occur along streams, the soil is a dark-brown to black clay loam, and the subsoil to 40 inches is a yellowish-brown silty or sandy clay. Beneath this is a brownish-yellow clay with occasional thin layers of sand. The soil when wet is sticky and plastic and presents all the objectionable features of "gumbo," making it a difficult soil to till. The upland phase occurs on an undulating prairie. The type is glacial in origin, except along streams and sloughs, where it is sedimentary. It is more or less affected by alkali salts, though not sufficiently so to interfere seriously with the growth of native grasses. Only in local spots does a white crust form on the surface. Artificial drainage is essential to the successful cropping of this soil, and applications of barnyard manure prove beneficial. Only a small proportion of this type is under cultivation.

	1	2	3	4	5	6	7
Soil (3)	1	3	4	14	15	31	31
Subsoil (3)	1	3	4	16	19	31	27

	Acres.
Carrington, N. Dak	6,272

Sarpy clay loam.—The soil is a stiff waxy gray to black clay from 12 to 24 inches deep, with an average depth of about 20 inches. The subsoil consists of gray or yellow fine silty sand. This is a bottom land type occupying depressed areas and generally requiring artificial drainage. It is of recent alluvial formation and is undergoing some change at the present time. When drained it makes excellent corn soil, the average

[a] Mapped as Oswego silt loam.

yield per acre being about 50 bushels. It is used to some extent for alfalfa where not overflowed, and excellent yields are secured.

	1	2	3	4	5	6	7
Soil (2)	0	0	0	3	9	51	37
Subsoil (2)	0	0	0	9	41	42	7

	Acres.
Sarpy County, Nebr.	2,816

Congaree clay.—The type consists of 3 feet or more of light-brown or chocolate-colored clay, containing a large percentage of silt. The material from 8 to 36 inches is a little lighter in color and a little heavier in texture than the top soil, and occasionally a thin seam of very fine sand is found. The terraces contain a little more sand than the low-lying areas, and often small particles of mica brought down from the Piedmont are scattered through the soil. This soil type commonly occurs in strips or terraces near rivers or streams, and frequent overflows make it an uncertain soil for crops. It is adapted to Bermuda grass, and good yields of corn and oats are secured in favorable seasons. The original timber growth is gum, hickory, cottonwood, and sycamore, with some pine and cypress.

	1	2	3	4	5	6	7
Soil (6)	0	0	2	5	9	48	36
Subsoil (6)	0	0	0	5	9	45	40

	Acres.
Macon County, Ala	[a] 4,800
Montgomery County, Ala.	11,712
Orangeburg. S. C.	2,944

Griffin clay.—This is a very compact soil, composed of medium to fine gravel, coarse sand rounded by water action, and clay. The clay is dark brown or mottled in color, very stiff and waxy, and difficult to work. There is an average gravel content of about 10 per cent. The type occupies the broad, level floor of Black River Valley. It is alluvial in origin, and the presence of so much gravel may be due to the reworking of glacial material. A large proportion of the type is covered by forest. Corn is the chief product, but considerable areas are devoted to wheat and oats.

	1	2	3	4	5	6	7
Soil (1)	2	12	19	13	4	25	25
Subsoil (1)	1	15	21	13	3	20	27

	Acres.
Posey County, Ind.	1,600

[a] Mapped as Ocklocknee clay.

Neuse clay.—This is a dark, tenacious, mottled gray clay, 3 feet or more in depth. It is a stream deposit, often subject to overflow, and occurring along stream bottoms in the Coastal Plain region of North Carolina. The soil is poorly adapted to agricultural purposes on account of its close, sticky nature and poor drainage, but when well drained it is a good cotton soil.

	1	2	3	4	5	6	7
Soil (4)	0	2	3	13	15	37	23
Subsoil (1)	0	1	0	5	30	39	24

	Acres.
Craven, N. C	1,792
McNeill, Miss	13,120
Raleigh to Newbern, N. C	3,040

Ocklocknee clay.[a]—This soil consists of from 8 to 15 inches of loam of variable texture, resting on a stiff, tenacious clay of dark-yellow, mottled-red, or black color. The subsoil contains a noticeable quantity of finely divided quartz rock. The type lies along the river, is subject to overflow, and very little of it is under cultivation.

	1	2	3	4	5	6	7
Soil (3)	1	2	4	20	13	29	30
Subsoil (3)	1	2	3	19	10	27	38

	Acres.
Bainbridge, Ga	832
Dallas County, Ala	29,056
Gadsden, Fla	3,712

Sharkey clay.[b]—The soil is a stiff, waxy, yellow clay 8 inches deep, containing lime and iron concretions. The subsoil is a stiff, impervious clay similar to the soil. The surface suncracks readily. The type is locally known as "buckshot land." It is a poorly drained soil occupying the lowest portions of river bottoms and is subject to overflow annually. When diked and well drained it is a strong soil, suited to corn, sugar cane, and cotton.

	1	2	3	4	5	6	7
Soil (21)	0	1	1	4	4	40	50
Subsoil (22)	0	1	0	2	3	38	50

	Acres.
Brazoria, Tex	133,056
East Baton Rouge Parish, La	18,432
Houston County, Tex	3,008
Lee County, Tex	28,096
New Orleans, La	157,952
Ouachita Parish, La	67,264
Paris, Tex	19,136
Smedes, Miss	149,440
Yazoo, Miss	184,380

[a] See also Congaree clay, p. 97.

[b] See also Miller clay, p. 92; Wabash clay, p. 87, and Waverly clay, p. 90.

SOILS OF THE PIEDMONT PLATEAU.

Lying between the Atlantic Coastal Plain and the Appalachian Mountains and extending from the Hudson River to East Central Alabama is an area of gently rolling to hilly country known as the Piedmont Plateau. On the Atlantic side it is closely defined by the "fall line" which separates it from the Coastal Plain, but on the northwestern side the boundary is not sharp, although in the main distinct. In its northern extension the Piedmont Plateau is quite narrow, but broadens toward the south, attaining its greatest width in North Carolina.

The surface features are those of a broad, rolling plain that has been deeply cut by an intricate system of small streams, whose valley walls are rounded and covered with soil, although many small gorges and rocky areas occur. The altitude varies from about 300 feet to more than 1,000 feet above sea level.

The extreme northern part of this Piedmont region, in New Jersey, has been glaciated, but elsewhere the soils are purely residual in origin, and have been derived almost exclusively from the weathering of igneous and metamorphic rocks. The chief exception is the detached areas of sandstones and shales of Triassic age. Marked differences in the character of the rock and in the method of formation have given rise to a number of soil types, those derived from crystalline rocks being the most numerous and widely distributed. Among these the soils of the Cecil and Chester series predominate. The principal types formed from the sandstones and shales are included in the Penn series.

CECIL SERIES.

The Cecil series, which is incomplete, includes the most important and widely distributed soils of the Piedmont Plateau. The heavier members are known as the "red-clay lands," and are characterized by red-clay subsoils, with gray to red soils ranging in texture from sand to clay, the lighter colors prevailing with the sandy members. A characteristic of the subsoil is the sharp quartz sand, which is always scattered through it, and occasional veins of quartz or flint rock. Particles and flakes of mica are usually present in the subsoil. The types are of residual origin, derived from the degradation of igneous and metamorphic rocks which have been weathered generally to great depths, so that outcrops are rare. Fragments and bowlders of the parent rocks are, however, found on the surface in varying quantities. The topography is rolling to hilly, with level areas existing where stream erosion has not been too great. The soils of the Cecil series produce general farm crops throughout their extent, and in the south cotton is also an important crop. Both heavy export and bright tobacco are generally grown, the character of the leaf produced depending on the depth and texture of the soil.

Cecil stony loam.—The soil varies from brown sandy loam to brown or red loam with an average depth of 8 inches, beneath which is a red clay loam or clay. From 30 to 60 per cent of the soil and subsoil is composed of stones and bowlders. This is a residual type derived principally through the weathering of intrusive dikes of trap rock, but in part from other igneous or metamorphic rocks. The surface is usually hilly and broken. The soil is adapted to general farm crops and apples.

	1	2	3	4	5	6	7
Soil (7)	4	8	6	13	9	38	21
Subsoil (7)	3	8	5	11	7	32	31

	Acres.		Acres.
Adams County, Pa	8,640	Lebanon, Pa	[b]22,500
Campobello, S. C	1,805	Montgomery County, Pa	7,808
Cherokee County, S. C	832	Trenton, N. J	[c]13,952
Lancaster County, Pa	[a]1,400		

Cecil stony clay.—The soil consists of a heavy red loam or clay 8 inches deep, underlain by a stiff red clay. Upon the surface and scattered through the soil and subsoil are 30 to 60 per cent of rock fragments and bowlders. The type occurs on small mountains and hills in the Piedmont Plateau. It is of residual origin, being derived from igneous and metamorphic rocks. It is generally too steep and stony for cultivation and best suited to pasturage and forestry.

	1	2	3	4	5	6	7
Soil (1)	0	2	2	23	13	18	42
Subsoil (1)	1	4	4	22	14	19	35

	Acres.
York County, S. C	1,280

Cecil gravelly loam.—The soil is a brown, sandy loam about 7 inches deep, carrying varying quantities of feldspathic or quartz gravel ranging in size from very small particles to fragments one-half inch in

[a]Mapped as Hempfield stony loam.
[b]Mapped as Cecil clay (stony phase).
[c]Mapped as Cecil loam.

diameter. The subsoil is a heavy, micaceous red loam or clay loam containing considerable gravel. Outcrops of granite frequently appear. The characterizing feature of the type is a lack of tenacity in both soil and subsoil, as a result of which the land erodes and gullies in a serious manner. It usually occupies high, broken uplands, and the drainage is good. This type has been derived from the breaking down of granites, chiefly of a coarse-grained variety, but represents a less complete weathering of the rocks than some of the other types of the Cecil series. Cotton, corn, and cowpeas are the principal crops grown. Some parts of the type are suited to the production of small fruits. The characteristic timber growth is hickory, shortleaf pine, and some cedar.

	1	2	3	4	5	6	7
Soil (2)	25	15	7	15	12	13	13
Subsoil (2)	16	12	6	14	9	16	29

	Acres.
Lancaster County, S. C	23,744

Cecil sand.—The soil is a coarse to medium loamy sand, or light sandy loam 6 inches deep, underlain with material of the same kind but of lighter color, and this in turn is underlain at from 18 to 22 inches by a yellow sandy clay. This is a residual type derived from granite, gneiss, and mica schist. Usually from 10 to 30 per cent of quartz and rock fragments are found in both soil and subsoil. The type gives low yields of cotton and corn. It is fairly good for truck, especially sweet potatoes and watermelons, and has been used to a considerable extent for bright tobacco.

	1	2	3	4	5	6	7
Soil (22)	8	14	11	28	14	16	7
Subsoil (19)	5	9	7	18	9	17	32

	Acres.		Acres.
Abbeville, S. C	[a]27,840	Hickory, N. C	[a]7,710
Alamance County, N. C	[a]84,900	Louisa County, Va	8,192
Appomattox, Va	960	Prince Edward, Va	[a]20,710
Campobello, S. C	2,086	Raleigh to Newbern, N. C	[a]20,950
Cary, N. C	[a]8,000	Spalding County, Ga	448
Cherokee, S. C	12,736	Statesville, N. C	[a]10,560
Hanover County, Va	29,696	York County, S. C	25,216

Cecil sandy loam.—The soil is a sandy loam of a brownish or yellowish color about 10 inches deep. The subsoil is a red clay containing coarse sand, both soil and subsoil carrying fragments of quartz. There

[a] Mapped as Durham sandy loam.

is usually considerable quartz on the surface. The type occupies high rolling land of the Piedmont Plateau and is derived from granite, gneiss, and other metamorphosed rocks. This is the best corn and cotton soil of the southern Piedmont. In Virginia it is used for both bright and dark shipping tobacco. This is the lightest desirable soil for general farming purposes.

	1	2	3	4	5	6	7
Soil (34)	6	14	11	25	13	18	11
Subsoil (35)	4	8	6	12	6	19	43

	Acres.		Acres.
Abbeville, S. C	236,288	Hanover County, Va	97,856
Albemarle, Va	47,808	Hickory, N. C	355,968
Appomattox County, Va	168,768	Lancaster County, S. C	20,672
Bedford, Va	33,740	Louisa County, Va	150,400
Campobello, S. C	85,888	Prince Edward, Va	91,710
Cary, N. C	26,090	Raleigh to Newbern, N. C	15,560
Cherokee County, S. C	105,024	Spalding County, Ga	54,464
Cobb County, Ga	23,170	Statesville, N. C	148,910
Covington, Ga	27,500	York County, S. C	88,768

Cecil fine sandy loam.—The soil is a light-gray fine sandy loam, grading into a pale yellow fine sandy loam of slightly more compact structure. It is underlain at from 10 to 15 inches by a stiff red clay, sometimes yellowish in local areas, which is sometimes underlain at a depth of more than 3 feet by talc schists or slates, together with a small proportion of other altered rocks. Quartz fragments and gravel usually characterize the soil, and veins and fragments of the same material occur in the subsoil. This type usually occupies undulating to rolling uplands, and has good drainage. It has been formed chiefly by the weathering of talcose schists and slates, though some other altered rocks enter into its formation. Cotton and corn are the main crops grown, but the soil is also adapted to stone fruits and small grain. It produces a fine-textured tobacco. The timber growth is hickory, oak, and pine, with gums in the swales and depressions.

	1	2	3	4	5	6	7
Soil (7)	1	3	3	21	39	22	10
Subsoil (7)	1	1	2	9	20	21	46

	Acres.		Acres.
Abbeville, S. C	[a] 25,856	Louisa County, Va	26,432
Cherokee County, S. C	33,792	York County, S. C	35,136
Lancaster County, S. C	28,096		

[a] Mapped as Davie clay loam.

Cecil loam.[a]—The soil consists of a pale yellow to brownish friable loam passing at from 5 to 8 inches into a pale yellow clay loam. This is underlain at 12 inches by a stiff red clay which sometimes at about 24 inches passes into soft, partially decomposed rock. Varying quantities of quartz fragments occur scattered over the surface and to a less extent throughout the soil section. The type is derived from talcose schist, occupies level to rolling uplands, and is generally well drained. While it produces poor yields of wheat, oats, corn, and tobacco, the soil is easily tilled and is susceptible of improvement.

	1	2	3	4	5	6	7
Soil (4)	1	3	3	11	15	46	19
Subsoil (3)	1	2	2	5	6	29	54

Louisa County, Va	108,992
Statesville, N. C	[b] 3,370

Cecil silt loam.—The soil is a light yellowish-gray to white silt loam 8 inches deep, frequently containing from 10 to 30 per cent of rock fragments. The subsoil is a light-yellow to red clay, becoming heavier with depth. The type occupies high, rolling areas, and is derived from highly metamorphosed crystalline rocks. Drainage is generally good. Areas of this type are frequently considerably eroded. The soil is fair to poor for cotton, corn, and wheat.

	1	2	3	4	5	6	7
Soil (8)	2	2	1	4	11	63	17
Subsoil (9)	1	2	1	3	7	51	33

	Acres.		Acres.
Alamance County, N. C	[c] 7,860	Leesburg, Va	4,928
Cherokee County, S. C	48,384	York County, S. C	37,376
Lancaster County, S. C	74,048		

Cecil clay loam.—The surface soil is a reddish-yellow or light-brown heavy loam with an average depth of 10 inches. The subsoil consists of reddish-yellow or light-brown heavy loam grading into clay loam at an average depth of 30 inches, sometimes changing to clay in its lower depths. From 10 to 30 per cent of stones and bowlders, principally syenite, are commonly present in both soil and subsoil. The surface is moderately to steeply rolling, with occasional small level

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[a] See also Cecil stony loam, p. 100, and Chester loam, p. 109.

[b] Mapped as Davie clay loam.

[c] Mapped as Alamance silt loam.

areas. Surface drainage is rapid, and small gullies are sometimes formed. The heavy subsoil is retentive of moisture. This soil has been derived chiefly from syenite, but in small local areas other metamorphic rocks have entered into its formation. This is a good corn soil, the average yield being 30 bushels per acre. It also produces good crops of wheat, oats, and hay.

	1	2	3	4	5	6	7
Soil (2)	1	4	2	4	5	50	34
Subsoil (2)	2	6	3	5	6	37	41

	Acres.
Adams County, Pa	40,960
Montgomery County, Pa	4,416

Cecil clay.[a]—This is a clay loam to clay soil of reddish color 6 inches deep, having a stiff, tenacious clay subsoil of red color. Both soil and subsoil contain quartz and fragments of undecomposed rocks. Occasional rock areas and isolated bowlders or "niggerheads" occur. The type occupies high, rolling land and is derived from gabbro and other eruptive rocks. This is recognized as the strongest soil of the Piedmont Plateau for general farming. It is adapted to grass, wheat, and corn in Maryland and Pennsylvania; export tobacco and wheat in Virginia; and to corn, wheat, and cotton in the Carolinas.

	1	2	3	4	5	6	7
Soil (36)	3	7	6	18	11	26	30
Subsoil (44)	2	4	4	10	6	25	47

	Acres.		Acres.
Abbeville, S. C	332,992	Hanover County, Va	7,360
Albemarle, Va	79,680	Harford County, Md	39,890
Alamance County, N. C	101,370	Hickory, N. C	120,704
Appomattox County, Va	31,232	Lancaster County, S. C	114,752
Bedford, Va	142,730	Leesburg, Va	32,000
Campobello, S. C	187,443	Louisa County, Va	7,168
Cary, N. C	2,960	Prince Edward, Va	31,590
Cecil County, Md	12,500	Raleigh to Newbern, N. C	2,030
Cherokee, S. C	22,592	Spalding County, Ga	66,560
Chester County, Pa	1,088	Statesville, N. C	289,590
Cobb County, Ga	166,130	York County, S. C	185,152
Covington, Ga	99,930		

[a] See also Cecil stony loam, p. 100.

PENN SERIES.

The Penn series consists of Indian or purplish red soils derived from the weathering of red sandstones and shales of Triassic age. Detached areas of Triassic rocks occur in shallow basins in the Piedmont from New England to South Carolina. In productiveness and crop adaptation the Penn series may be considered as intermediate between the Hagerstown and Cecil series. Corn, wheat, oats, potatoes, grass, apples, and peaches are produced on different members of the series in the more northern States. Tobacco is grown in Virginia and tobacco and cotton in the Carolinas.

Penn stony loam.—This type consists of very stony land, hilly to mountainous in character, generally covered with a natural forest of chestnut and oak. The soil consists of a rather heavy Indian-red loam, 8 to 10 inches deep, containing from 30 to 60 per cent of red or brown sandstone fragments. The subsoil is of much the same character to a great depth. This type is derived from the more siliceous or hardened phase of the Triassic sandstone. It is well adapted to forestry and orcharding, and the more level areas, when the stones are removed, to general farm crops.

	1	2	3	4	5	6	7
Soil (7)	2	5	4	9	12	40	27
Subsoil (7)	2	5	4	9	12	37	30

	Acres.		Acres.
Chester County, Pa	3,520	Leesburg, Va	1,280
Connecticut Valley, Conn. and Mass	[a] 109,116	Lockhaven, Pa	6,080
Lebanon, Pa	49,160	Trenton, N. J	5,632

Penn shale loam.—The soil is a dark Indian-red loam about 8 inches deep. The subsoil consists of a heavy Indian-red clay loam grading into clay, and is of variable depth, always resting upon the shale rock from which it is derived. From 10 to 40 per cent of shale fragments occur in the surface soil, giving it the local name of "red gravel land," and the quantity always increases in the subsoil. The drainage features of the type depend upon its topography, because the underlying beds of shale prevent the downward percolation of water to any great depth. This type is derived from the beds of shale which underlie it, excepting only the lower slopes and hollows, where the soil has been

[a] Mapped as Triassic stony loam, which name will not be used hereafter outside the Connecticut Valley.

augmented in varying degrees by wash from higher elevations. It usually occurs as broad, rolling valley land with surface features sometimes sharply broken. The soil is adapted to wheat, oats, corn, and hay.

	1	2	3	4	5	6	7
Soil (3)	6	12	3	7	5	36	30
Subsoil (3)	9	11	4	6	5	24	41

	Acres.
Adams County, Pa	100,032

Penn gravelly loam.—The soil is a dark-red or brown sandy loam about 8 inches deep containing from 10 to 60 per cent of small rounded sandstone gravel. The subsoil is a dark Indian-red loam or clay loam. The type occurs as high rolling upland and is derived generally from the Triassic red sandstone. The drainage is good, but the soil is inclined to wash badly. It produces fair yields of corn, wheat, vegetables and small fruit.

	1	2	3	4	5	6	7
Soil (2)	2	7	7	19	18	27	20
Subsoil (2)	5	7	4	9	17	35	23

	Acres.
Leesburg, Va	704

Penn sandy loam.[a]—The soil is a sandy loam from 6 to 15 inches deep, underlain by Indian-red or brown loam or clay loam. Sandstone fragments to the extent of from 5 to 20 per cent are generally present. The type is derived from the Triassic red sandstone. The surface varies from rolling to moderately hilly. The soil is easily tilled and produces crops of good quality but light yield.

	1	2	3	4	5	6	7
Soil (9)	2	12	9	21	9	28	17
Subsoil (8)	3	11	7	17	8	28	26

	Acres.		Acres.
Adams County, Pa	3,392	Lebanon, Pa	40,590
Albemarle, Va	5,568	Trenton, N. J	10,816

Penn loam.—The soil is a dark Indian-red loam from 8 to 12 inches deep, underlain by an Indian-red clay loam. Both soil and subsoil occasionally contain from 5 to 20 per cent of sandstone fragments. The surface is gently rolling. The type is derived from fine-grained brown or red Triassic sandstone. The drainage is fair, but plowing in beds is generally practiced to assist the natural drainage. The soil is considered almost equal to associated limestone soils in fertility.

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[a] See also Upshur sandy loam.

	1	2	3	4	5	6	7
Soil (11)	3	5	4	8	12	47	22
Subsoil (11)	3	6	3	8	11	43	26

	Acres.		Acres.
Adams County, Pa	54,592	Leesburg, Va	18,880
Chester County, Pa	28,672	Trenton, N. J	171,712
Lebanon, Pa	26,890		

Penn silt loam.—The soil consists of reddish or reddish-brown silt loam from 8 to 12 inches deep. The subsoil is a red or light-brown silt loam somewhat heavier than the soil and grading usually into a red silty clay loam in its lower depths. Both the soil and subsoil contain from 5 to 15 per cent of shale and sandstone fragments. The surface ranges from slightly to steeply rolling. The drainage on most of the areas is very good, but on slopes where the bed rock lies near the surface seepy tracts are often encountered. The type is derived from a sandstone of Triassic age. It is best adapted to the general farm crops. The average yields are, corn 50 bushels, oats 30 bushels, wheat 20 bushels, and hay 1¼ tons per acre.

	1	2	3	4	5	6	7
Soil (4)	2	4	2	3	6	62	21
Subsoil (4)	1	3	2	3	5	60	26

	Acres.
Montgomery County, Pa	61,824

Penn clay.[a]—The soil is a dark Indian-red to dark reddish-brown clay about 8 inches deep. The subsoil is a dark Indian-red clay grading into a stiffer clay. The type occurs in gently rolling upland as a series of low ridges. The drainage is good. The type is of residual origin from Triassic red sandstone and shale. Wheat, corn, and grass are the principal crops.

	1	2	3	4	5	6	7
Soil (5)	5	3	2	7	14	36	36
Subsoil (4)	2	3	2	4	12	32	45

	Acres.
Albemarle, Va	16,128
Leesburg, Va	11,776

[a] See also Upshur clay, p. 123.

CHESTER SERIES

The Chester series occurs in the northern part of the Piedmont, having been found and mapped only in Pennsylvania, Maryland, and Virginia. This series differs from the Cecil series in having yellow or only slightly reddish subsoils and gray or brown surface soils which are, on the whole, lighter and more friable than those of the Cecil series. The members of this series are also much more micaceous and even more subject to erosion than the soils of the Cecil series. Locally they are known as "gray lands" to distinguish them from the "red lands" of the Cecil series. The topography in general is not so rough, being rolling to moderately hilly.

The soils are of residual origin, derived from igneous and metamorphic rocks, principally mica schists. The weathering has not gone on so deeply as in the case of the Cecil series, and the underlying rock is often encountered within 2 feet of the surface on slopes where erosion is pronounced and rarely lie more than 10 to 15 feet below the surface. The soils of the Chester series are adapted to general farm crops, especially corn, and also to fruit and canning crops. Of the latter tomatoes and sugar corn are the most important. The soils are not so strong as those of the Cecil series, requiring more careful treatment to keep up the yields.

Chester stony loam.—The surface soil has an average depth of 10 inches, and consists of a medium to heavy brown loam. The subsoil is a yellow or yellowish-red clay loam that usually grades into stiff clay at depths ranging from 24 to 36 inches. Stone and bowlders are scattered over the surface and mixed with both soil and subsoil in quantities varying from 30 to 60 per cent. This type occurs in small irregular areas associated with the Chester loam. The topography varies from moderately rolling to hilly, and the type forms steep slopes and the summits of hills and ridges. The drainage is good. The type is derived from the weathering of gneisses and schists. A few areas are derived from granite. Much of this type is used as permanent pasture, though where the slopes are not too steep good crops are secured. In good seasons corn yields 50 bushels, oats 35 bushels, wheat 20 bushels, potatoes 120 bushels, and hay $1\frac{1}{2}$ tons per acre.

	1	2	3	4	5	6	7
Soil (2)	4	7	3	6	5	52	23
Subsoil (2)	4	6	3	5	6	45	31

	Acres.
Chester County, Pa.	20,864

Chester fine sandy loam.—The soil consists of a brown or yellow fine sandy loam 10 inches deep, generally quite sandy on the lower slopes. The subsoil is a yellow fine sandy loam to fine sand. It often contains considerable rock fragments and occasionally is distinctly micaceous. The type is derived from a fine-grained sandstone and schist. The type occupies moderately to steeply rolling country and generally has good surface and underdrainage. Where the topography is suitable, this soil is adapted to the production of early garden crops and potatoes.

	1	2	3	4	5	6	7
Soil (2)	1	9	7	24	17	27	15
Subsoil (2)	2	8	8	26	15	29	12

	Acres.
Chester County, Pa	1,472
Montgomery County, Pa	4,608

Chester mica loam.—The soil consists of a loose loam or yellowish loam 12 inches deep, underlain by a heavier loam or light clay loam of yellowish or reddish-yellow color. Usually at a depth of 30 inches or more it grades into the decomposed rock. This soil is closely related to the Chester loam, its distinguishing feature being the greater quantity of micaceous particles, giving the soil a loose consistency and a soft, rather greasy feel. It is derived from a very micaceous series of metamorphic and igneous rocks. The topography is rolling to hilly. The soil is devoted to the same crops as the Chester loam and is its equal in productivity. It erodes even more readily than the Chester loam.

	1	2	3	4	5	6	7
Soil (8)	4	7	6	18	16	30	18
Subsoil (8)	5	7	5	22	14	29	17

	Acres.		Acres.
Cecil County, Md	[a] 10,000	Leesburg, Va	[a] 4,608
Harford County, Md	[a] 39,930	Montgomery County, Pa	640
Lancaster County, Pa	[a] 10,000	Prince George County, Md	[a] 600

Chester loam.—The soil consists of a brown or yellowish loam, sometimes slightly sandy, containing some mica. This is underlain by a heavy yellow loam subsoil grading into clay loam which in lower depths becomes somewhat lighter in texture and more micaceous. The color is sometimes reddish yellow or red. Fragments of quartz and other rocks are usually found on the surface and throughout the soil section. It is a residual soil derived largely from gneiss and mica schist, but other

[a] Mapped as Cecil mica loam.

metamorphic and igneous rocks may also enter into its composition. The surface is rolling to hilly and drainage is good. The soil is good for general farming purposes, but requires careful treatment on slopes where it washes badly.

	1	2	3	4	5	6	7
Soil (14)	4	6	4	10	10	41	25
Subsoil (14)	4	6	4	10	9	37	28

	Acres.		Acres.
Adams County, Pa	[a] 8,448	Chester County, Pa	202,368
Albemarle, Va	[a] 94,592	Harford County, Md	[a] 110,220
Appomattox County, Va	[a] 1,408	Leesburg, Va	[a] 89,600
Cecil County, Md	[a] 52,600	Montgomery County, Pa	40,640

MISCELLANEOUS SOILS OF THE PIEDMONT PLATEAU.

Manor stony loam.—The soil to a depth of from 8 to 10 inches consists of a clay loam or heavy loam about 8 inches deep containing large quantities of small rock fragments. The subsoil is a light-yellow or slightly grayish loam to clay loam. The subsoil always contains a high percentage of small schist fragments and sometimes is a mass of these with the interstitial spaces filled with soil. The surface is hilly to mountainous. The type is derived principally from mica schists. Where cultivation is possible, the soil produces fair yields of the staple crops. It is largely forested.

	1	2	3	4	5	6	7
Soil (5)	4	5	2	8	14	44	22
Subsoil (5)	5	7	3	11	17	36	20

	Acres.
Chester County, Pa	33,408
Lancaster County, Pa	3,500
Montgomery County, Pa	2,048

Conowingo barrens.—This type represents a condition rather than a distinct soil. The soil covering is usually very shallow, seldom exceeding 3 feet, and in many places the surface material consists of broken rock fragments, with little or no interstitial material. The soil varies in texture from a coarse sandy loam to a loam or silty loam, the heavier classes predominating. The material occupies rolling to hilly and broken uplands and is derived from the decomposition of serpentine or rocks of similar nature. It is generally unproductive and worthless for agricultural purposes, owing to the slight depth of the soil and its stony, leachy character. The types support a stunted growth of trees.

[a] Mapped as Cecil loam.

	1	2	3	4	5	6	7
Soil (2)	3	3	2	6	10	50	23
Subsoil (2)	1	2	2	5	9	53	23

	Acres.		Acres.
Albemarle, Va	6,976	Chester County, Pa	2,944
Cecil County, Md	2,000	Harford County, Md	3,280

Cardiff slate loam.—The soil is a heavy yellowish-brown loam having a depth of about 8 inches, underlain by heavy yellow silty clay to a depth of 3 feet or more. Both soil and subsoil contain from 15 to 40 per cent of partially decomposed slate fragments. The type occurs on prominent narrow ridges and is derived from the decomposition and breaking up of fine-grained slate. The presence of the slate fragments in the soil makes quite friable what would otherwise be a refractory clay. Much of the type is forested with oak, chestnut, and other trees. The soil produces fair crops of corn, wheat, rye, oats, and grass.

	1	2	3	4	5	6	7
Soil (2)	1	2	1	2	9	49	33
Subsoil (2)	2	2	2	3	7	46	37

	Acres.
Adams County, Pa	768
Harford County, Md	1,690

Loudoun sandy loam.—The soil is a heavy brown or gray sandy loam about 8 inches deep, underlain by a heavy yellow or red loam or clay loam. There is a considerable variation in the subsoil, coarse sand often forming so large a proportion as to give it almost the texture of the soil. The surface material is not a loose sandy loam, but has the properties of a loam, containing, however, considerable quantities of coarse quartz fragments. The soil resembles in some respects the Cecil sandy loam and Chester loam with which it is associated. The type occurs in rolling and somewhat hilly areas, generally well drained, and is derived from the weathering of a coarse-textured schist and an eruptive crystalline granite, the original rock containing a large amount of feldspar. This is a good soil for corn, yielding from 40 to 50 bushels per acre. It is too little retentive of moisture for wheat, which produces only from 10 to 15 bushels, but is a fairly good soil for grass and clover.

	1	2	3	4	5	6	7
Soil (3)	6	16	10	15	8	24	20
Subsoil (3)	5	12	9	10	7	25	29

	Acres.
Leesburg, Va	27,968

Worsham sandy loam.—The soil is a gray sandy loam, generally of fine texture and of soft whitish appearance, having an average depth of 12 inches. The subsoil is a yellowish, sticky sandy loam or loam to a stiff plastic yellow clay mottled with white. The type is of residual origin, being derived from granites, gneisses, and schists, and was originally post-oak land. The soil is adapted to clover, grasses, hay, and pasturage.

	1	2	3	4	5	6	7
Soil (2)	3	8	9	23	20	29	7
Subsoil (2)	3	6	5	16	11	24	32

	Acres.
Prince Edward, Va	8,520

Brandywine loam.—The soil consists of a brown loam about 8 inches deep containing a small quantity of finely divided mica. The subsoil is a light-brown to yellowish light loam to heavy fine sandy loam, usually with a somewhat greasy feel, on account of the presence of mica particles. The mica content is so high in places as to give the subsoil a flaky characteristic. The type occupies irregularly rolling and hilly country having excellent drainage. It sometimes erodes so badly that cultivation other than to grass is unprofitable. The type is residual, being derived from mica gneiss, pegmatite, and sometimes mica schist. The soil is moderately productive and is adapted to general farming.

	1	2	3	4	5	6	7
Soil (2)	3	6	3	12	13	42	21
Subsoil (2)	3	9	4	20	13	33	18

	Acres.
Chester County, Pa	24,000

Manor loam.—The soil consists of a yellow or yellowish brown heavy loam 8 inches deep. The subsoil consists of a yellow or reddish-yellow heavy loam which grades into a clay loam at a lower depth. Mica schist fragments sometimes occur throughout the soil profile, while occasionally the lower portion of the subsoil consists largely of small mica particles, which render it feathery and fluffy. The topographic feature of the type ranges from gently to moderately rolling, with occasional hilly areas. It is well drained and washes in the steeply rolling areas. It is derived from hydromica schists. This soil produces fair yields of general farm crops.

	1	2	3	4	5	6	7
Soil (4)	3	3	1	6	11	54	22
Subsoil (4)	3	5	2	6	10	49	25

	Acres.
Chester County, Pa	75,840
Montgomery County, Pa	896

Lansdale silt loam.—The soil consists of a brown or slate-colored medium to heavy silt loam from 10 to 14 inches deep. The subsoil to a depth of 36 inches or more consists of a silty clay loam or heavy silty loam, grading into silty clay loam at an average depth of 20 inches. The subsoil ranges from pale yellow to yellowish gray in color and is generally lighter than the surface soil. The surface ranges from gently to moderately rolling and the drainage is adequate. This type is derived from fine-grained sandstone and shale of Mesozoic age. It is adapted to the production of general farm crops. Corn gives an average yield of 50 bushels, oats 35 bushels, wheat 20 bushels, rye 25 bushels, hay $1\frac{3}{4}$ tons, and potatoes 135 bushels per acre.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	5	5	68	19
Subsoil (3)	0	1	1	4	5	66	23

	Acres.
Chester County, Pa	5,248
Montgomery County, Pa	93,888

Iredell clay loam.—The soil is a dark-brown loam about 8 inches deep, containing small rounded iron concretions on the surface. The subsoil is a stiff, impervious yellow clay, underlain by soft decomposed rock. The type occupies level or slightly rolling areas and is of residual origin, being derived from diorite and similar intrusive rocks. It is locally known as "black jack" or "beeswax" land, the latter term being suggestive of the character of the subsoil. Level areas are inclined to be swampy on account of the impervious nature of the clay subsoil. This is considered a fair cotton, corn, and wheat soil.

	1	2	3	4	5	6	7
Soil (15)	9	8	4	16	17	32	12
Subsoil (16)	2	2	2	9	8	28	45

	Acres.		Acres.
Abbeville, S. C	14,848	Louisa County, Va	10,304
Alamance County, N. C	18,760	Prince Edward, Va	103,070
Appomattox County, Va	9,664	Statesville, N. C.	22,340
Cherokee County, S. C	1,344	York County, S. C	40,640
Leesburg, Va	18,048		

Conowingo clay.—The soil is a yellow to brown or reddish-brown loam about 8 inches deep, underlain by a yellowish-red to red clay or clay loam. In the subsoil decomposed fragments of steatite give a greasy feel. Occasionally rock fragments occur on the surface, but not to exceed 25 per cent. The type is derived from the decomposition of serpentine, steatite, talc schist, and similar rocks, and occupies rolling lands in the Piedmont Plateau. The soil is fairly productive for general agriculture, comparing favorably with the Cecil clay and Cecil loam. It is known in Maryland as productive "serpentine land."

	1	2	3	4	5	6	7
Soil (7)	5	8	5	13	12	35	21
Subsoil (6)	5	7	4	9	7	30	36

	Acres.		Acres.
Albemarle, Va	6,272	Harford County, Md	6,510
Cecil County, Md	3,000	Hickory, N. C	29,952
Chester County, Pa	4,160		

SOILS OF THE APPALACHIAN MOUNTAINS AND ALLEGHENY PLATEAUS.

The Appalachian Mountains are made up of a number of parallel ranges and intervening valleys which extend in a general northeast and southwest direction from southern New York to northern Alabama. The elevation ranges from about 1,500 to nearly 7,000 feet above sea level, the highest point being attained in western North Carolina.

Immediately west of the Appalachian Mountains and usually separated from them by a valley is a wide stretch of country known as the Allegheny Plateaus. In a broad way these plateaus are carved out of a great block of sedimentary rocks tilted to the northwest from the mountains. The plateaus are crossed by numerous streams. As they run in deep channels (all the larger ones being from 200 to 1,000 feet in depth) the dissection of the plateau block is often minute, and thus many plateaus have been formed.

The rocks of the eastern ranges of the Appalachian Mountains are igneous or metamorphic in origin, while the western ranges, as well as the Allegheny Plateaus, are made up of sedimentary rocks. Different series of soils have, therefore, been formed in different parts of these mountains and plateaus. The igneous and metamorphic rocks give rise to the soils of the Porters series, while the Dekalb and Upshur series are formed from the weathering of the sandstones and shales of sedimentary origin.

The character of the topography in the mountain and much of the plateau region is such that general farming is not practicable. These areas are, however, well suited to grazing and fruit growing and these are very important industries.

PORTERS SERIES.

The Porters series includes the residual soils of the Appalachian Mountains derived from igneous and metamorphic rocks. The soils are analogous to those of the Cecil series, but are classed separately on account of the difference in topographic position. The mountainous character of the country in which the Porters soils are found renders them difficult of cultivation. They occur at high elevations and so are influenced more or less by different climatic and drainage conditions. On the more level and less elevated areas wheat, corn, rye, and barley, and some fruit, particularly apples, are produced. At a medium elevation and under suitable conditions of slope and exposure fruit is the principal crop. Cattle raising is one of the most important industries. The soils seem eminently adapted to fruit culture, and this industry is rapidly extending and is destined to take on much larger proportions.

Porters stony loam.—The soil is a grayish-yellow sandy loam about 10 inches deep, mixed with fragments of sandstone and other rocks. The subsoil grades from a reddish-brown clay loam to a stiff red clay in lower depths, and contains some coarse sand and a large percentage of sandstone fragments. The type occupies rolling valley lands and gentle slopes of mountains. The soil is colluvial, derived from wash from the mountains, but the subsoil is derived from the decomposition of underlying rocks. The soil produces good crops of wheat, corn, grass, tobacco, rye, and apples.

	1	2	3	4	5	6	7
Soil (9)	9	10	6	15	10	32	16
Subsoil (7)	6	7	5	14	9	31	25

	Acres.		Acres.
Adams County, Pa	41,472	Hickory, N. C	25,152
Alamance County, N. C	[a] 15,970	Statesville, N. C	[a] 8,130
Cobb County, Ga	[a] 2,020		

Porters sand.—The soil is a grayish-yellow coarse sand about 10 inches in depth, overlying coarse sand and masses of broken rock. Fragments of rock and huge bowlders are scattered on the surface. The

[a] Mapped as Herndon stony loam.

type occupies mountain slopes and is derived through weathering from granite, gneiss, and similar rocks. Where slopes are not steep the soil is used to some extent for general farming. Formerly bright tobacco was grown. It is adapted to peach and grape culture.

	1	2	3	4	5	6	7
Soil (14)	11	18	11	22	11	15	11
Subsoil (14)	12	20	13	22	10	14	9

	Acres.		Acres.
Albemarle, Va	115,136	Hickory, N. C	11,136
Asheville, N. C	13,056	Mount Mitchell, N. C	42,816
Campobello, S. C	15,238		

Porters sandy loam.—The soil consists of a grayish-yellow sandy loam from 6 to 15 inches deep. The subsoil is a tenacious red clay. Both soil and subsoil contain fragments of quartz and other rocks. The type occupies mountain or high rolling lands and is of residual origin, being derived from igneous rocks. Wheat, corn, oats, rye, potatoes, and fruit are the principal crops.

	1	2	3	4	5	6	7
Soil (14)	7	14	10	23	13	19	13
Subsoil (14)	6	12	7	18	13	20	24

	Acres.		Acres.
Asheville, N. C	41,792	Mount Mitchell, N. C	76,480
Bedford, Va	[a] 46,150	Hickory, N. C	49,920
Campobello, S. C	13,267		

Porters black loam.—The soil is a rich, dark loam about 15 inches deep, mixed with rounded and angular fragments of rock often several feet in diameter. The subsoil is a yellowish-brown or reddish clay loam containing a large percentage of rock. The type occupies the steep slopes of the higher mountains and is of residual origin, being derived from granite, gneiss, and similar rocks. The soil is productive, but the slopes are too steep and stony to admit of extensive cultivation for general farm crops. It is especially adapted to apples, particularly the Albemarle pippin. For this apple the small coves on the east side of the mountains are considered most desirable. Where exposed on the top of the mountains it has little value for fruit and is used only for grazing.

[a] It is now recognized that a part of this should have been mapped as Dekalb stony loam.

	1	2	3	4	5	6	7
Soil (15)	6	9	7	16	10	26	23
Subsoil (12)	5	9	6	15	9	26	26

	Acres.		Acres.
Albemarle, Va	68,736	Hickory, N. C	512
Asheville, N. C	24,064	Mount Mitchell, N. C	87,808
Bedford, Va	8,270		

Porters loam.—The soil consists of a dark-red or gray loam from 6 to 15 inches deep. The subsoil is a tenacious red clay. Both soil and subsoil contain fragments of quartz and other rocks. The type occupies mountain or high, rolling lands, and is derived from igneous rocks. Wheat, corn, oats, rye, potatoes, and fruit are the principal crops.

	1	2	3	4	5	6	7
Soil (3)	4	10	8	18	11	24	25
Subsoil (3)	3	7	6	13	7	20	44

	Acres.
Asheville, N. C	180,416

Porters clay.—The soil is a reddish-brown clay loam about 6 inches deep, underlain by a stiff, tenacious red clay to a depth of 20 inches or more. Both soil and subsoil contain a large percentage of stone. The type occupies mountain slopes. This is a residual soil derived from granite and other crystalline rocks. When not too stony and rough it produces good crops of corn, wheat, and grass. It is one of the important apple soils of the mountains, particularly for Winesap and similar varieties.

	1	2	3	4	5	6	7
Soil (14)	3	7	6	12	9	30	32
Subsoil (14)	3	6	4	10	8	26	43

	Acres.		Acres.
Adams County, Pa	27,264	Campobello, S. C	13,005
Albemarle, Va	32,512	Hickory, N. C	7,552
Asheville, N. C	49,152	Leesburg, Va	2,752
Bedford, Va	[a] 28,240	Mount Mitchell, N. C	98,624

DEKALB SERIES.

The Dekalb series is derived from the disintegration of sandstones and shales, from Silurian to Carboniferous in age. The surface soils are gray to brown in color, while the subsoils are commonly some shade of yellow. The surface features consist of gently rolling table-lands, hills,

[a] Mapped as Porters red clay.

and mountains. The soils are generally not very productive. The stony and sandy members of the series are well adapted to orchard fruits, while the heavier soils make good hay and pastures.

Dekalb stony loam.—The soil is a gray to yellowish sandy loam from 6 to 10 inches deep, grading into a subsoil of slightly heavier texture and yellower color. In some places the subsoil approaches more nearly a true clay. Both soil and subsoil contain a large quantity of sandstone, conglomerate, and sandy calcareous shale fragments. The soil frequently rests directly upon a broken mass of rock. The topography is very rough and broken. Owing to the character of the surface and its very stony nature, the soil is not very productive, although where the clay subsoil prevails and a part of the stones are removed fair crops are produced. With proper location and elevation the sandy and sandy loam phases are well adapted to peaches. Where wheat is grown the soil produces a small yield of bright, heavy grain. The native growth consists mainly of chestnut and white oak, with some hickory, black gum, and red oak.

	1	2	3	4	5	6	7
Soil (21)	3	7	7	19	14	33	18
Subsoil (21)	4	8	7	18	13	26	23

	Acres.		Acres.
Adams County, Pa	4,224	Lebanon, Pa	[a] 20,300
Albemarle, Va	[a] 134,656	Leesburg, Va	19,072
Chester County, Pa	14,528	Lockhaven, Pa	111,872
Fort Payne, Ala	37,120	Montgomery County, Pa	1,472
Greeneville, Tenn	99,072	Pikeville, Tenn	32,128
Lancaster County, Pa	[a] 13,000	Upshur County, W. Va	82,560

Dekalb shale loam.—The soil to an average depth of 8 inches consists of a brown to yellowish loam or clay loam, underlain by yellowish or sometimes slightly reddish clay loam increasing in clay content with depth, grading into stiff clay resting upon a mass of broken shale fragments at depths rarely exceeding 24 inches. On the surface and throughout the soil and subsoil are scattered varying quantities of weathered shale fragments, the content usually increasing with depth. The surface features consist of smooth rounded knobs and ridges, with narrow intervening valleys. The type is of residual origin and is derived from sandy to argillaceous and more or less calcareous shales. The soil is heavy and droughty and is best adapted to grain and grass crops.

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[a] Mapped as Edgemont stony loam.

	1	2	3	4	5	6	7
Soil (15)	8	6	3	6	7	39	30
Subsoil (9)	5	6	3	7	7	33	38

	Acres.		Acres.
Albemarle, Va	[a] 75,328	Lebanon, Pa	[a] 142,210
Bedford, Va	[a] 25,370	Leesburg, Va	[a] 8,000
Chester County, Pa	1,408	Lockhaven, Pa	[a] 25,728
Greeneville, Tenn	64,896	Madison County, Ky	18,880
Lancaster County, Pa	[a] 15,000	Montgomery County, Pa	68,992

Dekalb gravelly loam.—This type is composed of a surface soil of brown loam or heavy sandy loam with a depth of 8 to 12 inches, resting upon a subsoil of light-yellow loam. From 5 to 30 per cent of fine quartz gravel occurs in the soil and the content of this material increases with depth. The type occupies ridges and hills and sometimes the intervening depressions. It is derived from the weathering of the Potsdam conglomerate. The drainage is well established, and crops are liable to suffer in dry seasons from lack of moisture. The type is fairly well adapted to general farm crops.

	1	2	3	4	5	6	7
Soil (1)	5	24	11	12	11	27	10
Subsoil (1)	5	28	12	10	8	20	17

	Acres.
Montgomery County, Pa	4,800

Dekalb sandy loam.—The soil consists of a gray to brown sandy loam of medium to fine texture from 9 to 12 inches deep, resting on a yellowish-brown, slightly sticky sandy loam. The type is residual in origin, derived from sandstone rock, and occurs in rather level areas. Occasionally broken sandstone lies directly under the surface soil. This is an easily cultivated type and responds readily to fertilizers, but is not very productive. Some wheat is grown, but the average yield is not more than 7 bushels per acre. The yield of corn rarely exceeds 15 to 20 bushels, while cotton gives from 200 to 350 pounds of lint per acre. This soil is adapted to vegetables and very well adapted to apples and peaches.

	1	2	3	4	5	6	7
Soil (4)	1	6	18	27	8	25	15
Subsoil (5)	1	4	12	29	9	24	21

	Acres.		Acres.
Blount County, Ala	168,512	Lebanon, Pa	[b] 11,220
Fort Payne, Ala	182,656	Pikeville, Tenn	163,392

[a] Mapped as Hagerstown shale loam.
[b] Mapped as Dauphin sandy loam.

Dekalb fine sandy loam.—The soil is a fine compact sandy loam from 8 to 12 inches deep, resting upon a subsoil of similar material, becoming more loamy as the depth increases. The type is derived from sandstone. The soil is naturally not productive, and small crops are obtained unless heavily fertilized. With proper cultivation it is fairly well adapted to fruit and truck. The principal timber is chestnut and oak.

	1	2	3	4	5	6	7
Soil (2)	1	1	6	45	6	28	10
Subsoil (2)	1	1	5	36	6	34	17

	Acres.		Acres.
Blount County, Ala	93,504	Madison County, Ky	832
Chester County, Pa	5,632	Webster County, Mo	3,584
Huntsville, Ala	2,240		

Dekalb loam.—The soil is a fine-textured loam of light-brown or yellowish color and from 10 to 15 inches deep. The texture becomes heavier as the depth increases, and the material grades finally into a light-yellow silty clay or clay subsoil, often mottled with gray or drab, which extends to a depth of 3 feet or more. The subsoil rests upon a mass of freshly disintegrated sandstone, beneath which is found bed rock. Sandstone fragments are usually scattered over the surface and some iron concretions also occur. The type occupies ridges varying from deeply dissected to broad and gently rolling topography. It is well drained, and in some situations is subject to erosion. This is a residual soil derived from a very fine-grained sandstone. This is an excellent type for general farming, potatoes, and other vegetables, melons, small fruits, and tobacco. Corn yields from 35 to 60 bushels, hay from 1 to 1½ tons, oats from 35 to 50 bushels, and wheat about 15 bushels per acre.

	1	2	3	4	5	6	7
Soil (5)	3	8	4	8	7	49	22
Subsoil (5)	2	7	4	7	6	45	27

	Acres.
Madison County, Ky	20,800
Chester County, Pa	11,456
Upshur County, W. Va	14,912

Dekalb silt loam.—The soil is a mellow loam or silt loam of a gray, brown, or yellow color, from 8 to 20 inches deep, with an average depth of 14 inches. The sand constituent is of the finer grades, and this, with the large silt content, gives the soil the character of a mellow silty loam. The line between soil and subsoil is nowhere sharply drawn. The subsoil is a silty clay loam, not plastic nor tenacious. It has a characteristic yellow color, but lighter than that of the soil because of the lack of organic matter. Unweathered rock is often encountered at a depth of less than 3 feet, and nearly everywhere fragments of shale or shaly sandstone are scattered through the soil and over the surface. The type covers hilly uplands with a more broken surface near the streams. Away from the streams the surface is rolling, and this is the character of the greater part of the type. Its topography admits of easy drainage. The soil is not retentive of moisture, though with the rainfall usual in the regions where it occurs crops seldom suffer seriously from drought. The tendency to wash and gully is not so great as in many soils of similar topography. The steep hillsides, however, should not be planted to cultivated crops. It is a residual soil, formed by the decomposition of the shales, sandstones, sandy shales, and limestones of the Carboniferous period. The original rocks contained some iron, and this is manifested in the soil by occasional iron concretions. Corn, wheat, and timothy are the most important cultivated crops. Much of the hilly and stony land is unfit for cultivation, but is well adapted to grasses. In the extremely rough portions the land is still in forests of hardwood.

	1	2	3	4	5	6	7
Soil (7)	1	2	3	4	7	61	21
Subsoil (5)	1	2	3	7	10	46	29

	Acres.		Acres.
Coshocton County, Ohio	320,064	Scott County, Ind	22,080
Greeneville, Tenn	10,560	Warren County, Ky	89,408
Madison County, Ky	31,424		

Dekalb clay.—The soil consists of about 8 inches of grayish-brown loam or clay loam, often containing much silt, underlain to a depth of 36 inches or more by a yellowish-brown to reddish-yellow clay. Both soil and subsoil usually contain from 10 to 40 per cent of small shale fragments. The usual topography of the type is hilly, and the natural drainage is good. The soil is derived from the weathering of shales belonging to the Coal Measures. It supports a timber growth consisting mostly of oak, hickory, beech, and pine. When cleared and cultivated fair yields of cotton, corn, vegetables, sorghum, and forage crops are secured. The higher ridges are suited to peaches and other orchard fruits.

	1	2	3	4	5	6	7
Soil (4)	5	5	2	7	10	35	36
Subsoil (4)	1	4	1	4	6	31	53

	Acres.		Acres.
Blount County, Ala	54,144	Upshur County, W. Va	40,768
Cleveland, Ohio	9,728	Westfield, N. Y	[a] 21,860

UPSHUR SERIES.

The Upshur series is closely associated with the Dekalb series, but is much less extensively developed. It is characterized and distinguished from the Dekalb series by the brown and red surface soils and the red subsoils. The series has been formed by the weathering of red sandstones and shales of Paleozoic age. The surface is rolling to mountainous, and drainage is well established. The soils of this series are generally more productive than the corresponding members of the Dekalb series.

Upshur sandy loam.—The soil to a depth of about 10 inches consists of gray to reddish gray medium to fine sandy loam, underlain by a deep-brown to red sandy clay subsoil. The surface of the type varies from gently rolling to hilly and rugged, and sometimes on the steeper slopes rock fragments occur. The natural drainage is good. The soil is derived from the weathering of a brown to red sandstone which forms a part of the Coal Measures. The original timber growth is oak, hickory, and pine. When well cultivated good crops of cotton, corn, and wheat are produced. It is suited also to vegetables, orchard fruits, and small fruits.

	1	2	3	4	5	6	7
Soil (2)	1	2	9	45	17	14	12
Subsoil (2)	0	4	14	30	8	20	25

	Acres.
Blount County, Ala	8,320
Fort Payne, Ala	[b] 576

Upshur loam.—The soil consists of about 8 inches of loam, varying from brown to dark Indian-red in color. The subsoil is a clay loam to a heavy clay, usually of a red-brown to a deep Indian-red color. The surface varies from flat to gently rolling or occasionally hilly. The type is derived from the weathering of a fine-grained red shaly

[a] Mapped as Dunkirk shale loam.
[b] Mapped as Penn sandy loam.

sandstone and is naturally well drained. The soil is productive and is well adapted to cotton, corn, and forage crops. Vegetables, orchard fruits, and small fruits do well on the lighter and higher lying areas of the type.

	1	2	3	4	5	6	7
Soil (2)	1	5	5	16	15	33	25
Subsoil (2)	1	4	2	9	11	35	38

	Acres.
Blount County, Ala	14,720

Upshur clay.—The soil is a stiff dark-red clay about 7 inches deep, underlain by a lighter-colored red clay of nearly the same texture. The type occupies steep hillsides, occasionally extending down into valleys, and suffers much from erosion. Exposed areas are inclined to bake and crack in dry weather. The type is the direct product of the weathering of shales. The soil is mainly used for pasturage, but the more gently rolling areas, susceptible of thorough cultivation, produce good crops of wheat, corn, and grass.

	1	2	3	4	5	6	7
Soil (4)	2	4	3	7	8	28	48
Subsoil (4)	1	6	4	8	6	25	50

	Acres.
Syracuse, N. Y	[a] 3,840
Upshur County, W. Va	13,504

SOILS OF THE LIMESTONE VALLEYS AND UPLANDS.

The limestone soils are among the most extensively developed of any in the United States and occur in both broad upland and inclosed narrow valley areas. The greatest upland development is seen upon the Cumberland Plateau in eastern Tennessee and Kentucky and upon the Carboniferous formation in central Tennessee and Kentucky, northern Alabama and Georgia, and in Missouri. The valley soils are found principally in Pennsylvania, Maryland, and Virginia, and in the mountain section of eastern Tennessee and Kentucky and northern Alabama and Georgia. The topography of the plateau soils varies considerably. In the Cumberland Plateau and Highland Rim the surface is undulating; in the region of the Ozark uplift in Missouri and Arkansas it is quite rough and hilly, and where there is an elevation of the surface, or where the plateau is deeply dissected by erosion, it presents a quite mountainous

[a] Mapped as Penn clay.

topography. The valley soils of the Appalachian region also show considerable topographic relief, sometimes exhibiting mountainous surface features.

The limestone soils are residual in origin, being derived from the weathering in place of limestone of differing age and composition. This is accomplished by the removal through solution of the calcium carbonate of the limestone, leaving behind the more resistant siliceous minerals. These soils are remarkable for the fact that they constitute but a very small percentage of the original limestone rock, the larger part having gone into solution. It has thus required the solution of many feet of rock to form 1 foot of soil.

The naturally heavy character of the limestone soils fit them for grain, grass, and general farming lands rather than for such early truck crops as are grown upon the lighter, coarser soils of the Atlantic Coastal Plain. They have found a special usefulness, however, particularly in certain sections of Tennessee and Kentucky, in the production of a heavy tobacco for export use.

Thus far the limestone soils east of Kansas and Texas and north of central Alabama and Georgia have been grouped in two important series, known as the Hagerstown and Clarksville.

HAGERSTOWN SERIES.

The Hagerstown series is formed mainly from the solution and subsequent filtration of pure massive limestone of Cambro-Silurian age. The soils of this series, as a rule, occur in valleys bordered by areas of the more resistant sandstones and shales. The series is most typically developed in the limestone valleys of the Allegheny Mountain region and in the central basins of Kentucky and Tennessee, but smaller areas are found as marginal deposits in the adjoining Piedmont section and in the deep valleys of the Appalachian Plateau, where the underlying limestones have been exposed to weathering by previous deep erosion. The most productive valley phase occurs in the large valley between the Blue Ridge and the Allegheny Mountains.

Hagerstown stony loam.—The soil to an average depth of 8 inches consists of a silty or fine sandy loam, usually brown in color but varying from light gray to yellowish. The subsoil consists of a yellow or yellowish-red clay loam grading at an average depth of 24 inches into a stiff red clay which extends to unknown depths. Upon the surface and occupying a large part of the soil and the first few inches of the subsoil occurs a high percentage of angular chert fragments. The type is residual and is derived from the solution of impure limestone containing cherty layers, the insoluble materials being concentrated on the surface. The type occupies high ridges in the limestone valleys. The natural drainage is thorough, but with its close subsoil the type is retentive of moisture and fertilizers. The soil is particularly well adapted to fruit growing. Of the field crops, corn succeeds best.

	1	2	3	4	5	6	7
Soil (4)	2	4	3	6	11	52	22
Subsoil (4)	2	3	2	4	7	38	44

	Acres.		Acres.
Adams County, Pa	1,408	Huntsville, Ala	41,984
Albemarle, Va	59,136	Lockhaven, Pa	22,016
Bedford, Va	[a] 11,950	Pikeville, Tenn	27,392

Hagerstown stony clay.—The soil consists of about 8 inches of brown to yellow clay loam, or clay underlain by yellow sticky clay. Usually limestone fragments are abundant in both soil and subsoil, and massive outcrops of hard, bluish-gray crystalline limestone frequently break the surface. The surface is usually rough, stony, and hilly, consisting of ridges and valley slopes. The type owes its origin to the weathering of limestones and shales of Silurian age. The soil is naturally quite productive, but owing to the large quantity of rock fragments and rock outcrop very little of it is under cultivation. Fair yields of corn, wheat, cotton, and forage crops are secured on the less stony areas.

	1	2	3	4	5	6	7
Soil (2)	1	5	5	10	5	29	45
Subsoil (2)	1	2	2	5	4	28	58

	Acres.
Blount County, Ala	6,848
Madison County, Ky	33,792

Hagerstown sandy loam.—The soil is a fine sandy loam about 12 inches deep, of a gray to yellowish or light-brown color. The subsoil is a yellowish-red clay grading into a stiff red clay. The type occupies some of the higher ridges of the valley and has good drainage. It is of residual and colluvial origin, being derived from limestone. Wheat, corn, and grass are grown. The soil is adapted to fruit, particularly peaches.

[a] Mapped as Murrill stony loam.

	1	2	3	4	5	6	7
Soil (10)	1	6	8	24	15	32	13
Subsoil (10)	0	3	4	14	9	31	38

	Acres.		Acres.
Albemarle, Va	45,504	Leesburg, Va	1,216
Bedford, Va	[a] 11,910	Pikeville, Tenn	5,760
Huntsville, Ala	8,064		

Hagerstown loam.—The soil is a brown or yellow loam 12 inches deep, underlain by a yellow clay loam to a depth of 24 inches, this in turn being underlain by a stiff, yellowish-red clay. The type occupies rolling valley land and uplands, and is derived from the weathering of pure massive limestone. This is the typical corn land of central Pennsylvania, Maryland, and the Shenandoah Valley of Virginia. It is one of the best types of general farming lands in the Eastern States and produces corn, tobacco, wheat, and grass.

	1	2	3	4	5	6	7
Soil (19)	5	3	3	7	10	46	28
Subsoil (19)	2	3	2	6	8	38	39

	Acres.		Acres.
Adams County, Pa	16,064	Lauderdale County, Ala	[d] 60,992
Albemarle, Va	30,784	Lawrence County, Tenn	[d] 10,880
Bedford, Va	40,520	Lebanon, Pa	93,110
Chester County, Pa	19,456	Leesburg, Va	4,864
Davidson County, Tenn	[b] 163,200	Madison County, Ky	107,072
Fort Payne, Ala	21,632	Montgomery County, Pa	11,840
Greeneville, Tenn	[c] 83,520	Mason County, Ky	24,384
Huntsville, Ala	138,944	Pikeville, Tenn	20,352
Lancaster County, Pa	45,000	Scott County, Ky	76,800

Hagerstown clay loam.—The soil is a heavy reddish loam or silty loam 24 inches deep, overlying stiff, tenacious red clay. The type occupies rolling valley land and is derived from the weathering of pure massive limestone. This is recognized as one of the strongest soils for general agricultural purposes and is well known for its large crops of wheat and corn.

	1	2	3	4	5	6	7
Soil (2)	1	3	2	5	9	64	16
Subsoil (3)	3	2	2	4	10	51	28

	Acres.
Lancaster County, Pa	21,000

[a] Mapped as Murrill sandy loam.
[b] Mapped in part as Davidson loam.
[c] Mapped as Fort Payne loam.
[d] Mapped as Clarksville clay loam.

Hagerstown clay.—The soil is a heavy brown to reddish-brown loam or clay 12 inches deep, underlain by a stiff, tenacious reddish-yellow or red clay. The type occupies rolling valley land and is derived from weathering of pure massive limestone. This is recognized as a very strong soil for general agriculture.

	1	2	3	4	5	6	7
Soil (8)	1	2	2	9	8	41	38
Subsoil (9)	0	1	1	6	5	29	56

	Acres.		Acres.
Albemarle, Va	25,920	Lancaster County, Pa	2,000
Bedford, Va	19,210	Leesburg, Va	4,224
Fort Payne, Ala	3,968	Madison County, Ky	43,392
Greeneville, Tenn	[a]21,568	Mason County, Ky	115,648
Huntsville, Ala	9,024	Scott County, Ky	102,528

CLARKSVILLE SERIES.

The Clarksville series is derived largely from cherty and fossiliferous limestone of the St. Louis group of the Subcarboniferous formation. These soils occur on both the level and undulating uplands and in rough, hilly country with steep valleys. When the latter surface features predominate the soils are generally unproductive and very stony, but in some sections are adapted to fruit, especially apples. The soils formed from beds of purer limestone occupying level and gently rolling areas are as a rule very productive, and are adapted to wheat, corn, and tobacco.

Clarksville stony loam.[b]—The soil is a gray or light-yellow to brown silty loam 6 inches in depth, overlying yellowish-red to red silty clay or clay 3 feet or more in depth. Both soil and subsoil contain 20 to 50 per cent of angular fragments of chert and siliceous limestone. The type occupies rough, broken country with deep-cut, narrow valleys. It is a residual soil, derived from cherty siliceous limestones and is thin and stony and of little agricultural value, and at present is largely covered with a thick second growth of oak timber. It is adapted to apples and peaches.

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[a] Mapped as Decatur clay.

[b] See also Rough stony land, p. 268.

	1	2	3	4	5	6	7
Soil (18)	2	3	2	6	5	58	22
Subsoil (19)	2	3	2	5	4	49	39

	Acres.		Acres.
Blount County, Ala	[a]44,992	Lawrence County, Tenn	263,296
Crawford County, Mo	324,608	Lauderdale County, Ala	235,712
Davidson County, Tenn	99,840	Montgomery County, Tenn	66,450
Fort Payne, Ala	[a]68,864	Saline County, Mo	7,296
Greeneville, Tenn	[a]64,386	Webster County, Mo	212,992
Howell County, Mo	499,264		

Clarksville fine sandy loam.—The soil, varying in depth from 6 to 15 inches, is a gray or light-orange fine sandy loam of loose texture. The subsoil, to a depth of more than 3 feet, is a red sandy clay, being more sandy in the upper portion. The surface features are not very uniform, varying from low, rolling hills to narrow ridges. The type has been formed largely from remnants of sandy layers of the Lafayette formation, mixed to a certain extent with the clays of the underlying limestone. Surface drainage is complete, but the subsoil is capable of retaining a large quantity of moisture. The soil should be excellent for peaches and, where well drained, for cotton and some other general farm crops.

	1	2	3	4	5	6	7
Soil (1)	1	3	10	43	11	25	8
Subsoil (1)	0	3	8	29	7	23	30

	Acres.
Lauderdale County, Ala	1,856

Clarksville silt loam.—The soil is a light-gray silt loam 8 inches deep, underlain by a yellowish compact silt loam, gradually changing to silty clay with depth. The color of the lower subsoil often changes to reddish-yellow or red. The type is of a residual origin, being derived from fossiliferous siliceous limestones. The surface is level to gently rolling. The larger and more level areas are generally poorly drained. The type is known locally as "Barrens" or "Flatwoods" and is largely forested with oaks. It is droughty and not considered strong, but with good treatment fair yields of the staple crops can be produced. In Tennessee and Kentucky this soil produces an excellent grade of export tobacco. Special crops, such as strawberries and cantaloupes and some vegetables, are grown successfully.

[a]Mapped as Fort Payne stony loam.

	1	2	3	4	5	6	7
Soil (17)	1	1	1	5	6	68	17
Subsoil (17)	1	1	1	5	4	59	28

	Acres.		Acres.
Crawford County, Mo	109,760	Montgomery County, Tenn	233,410
Howell County, Mo	40,384	Saline County, Mo	67,520
Huntsville, Ala	[a] 59,520	Warren County, Ky	232,832
Lauderdale County, Ala	104,320	Webster County, Mo	147,712
Lawrence County, Tenn	113,664		

Clarksville clay loam.—The soil is a brown to reddish-brown silty loam 8 inches deep, underlain by a heavy red silty clay loam to depth of 3 feet or more, the clay content increasing at lower depths. The type occupies gently undulating country and is usually well drained. It is a deep residual soil derived from the decomposition of limestone. It is a strong, fertile soil and is considered the best general farm land of the localities where it occurs. Tobacco of the export variety produces a heavy yield, but not a superior quality of leaf.

	1	2	3	4	5	6	7
Soil (3)	1	1	1	5	3	68	21
Subsoil (3)	1	1	1	4	2	54	36

	Acres.
Montgomery County, Tenn	27,460
Warren County, Ky	9,408

MISCELLANEOUS SOILS OF THE LIMESTONE VALLEYS AND UPLANDS.

Fort Payne sandy loam.—The soil to an average depth of 6 inches consists of a brown, light, very sandy loam, usually mixed with gravel and small fragments of stone. The subsoil is a sandy loam of lighter color, filled with rock fragments that have resisted weathering, and passing finally into partly decomposed rock. The depth of the soil is quite variable, in some places being 5 or 6 feet deep, while in others the unweathered rock comes to the surface. The type is the result of the weathering of the sandy dolomite, which is characteristic of the calciferous group of the Silurian. In some places glacial drift has entered to some extent into the composition of the soil. The topography of the type is usually hilly or rolling. The soil is productive and is suited to a variety of crops. Potatoes give large yields, and are of a superior quality. Besides the general farm crops the soil is adapted to sugar beets and other special crops.

[a] Mapped as Hagerstown silt loam.

	1	2	3	4	5	6	7
Soil (3)	1	6	11	36	22	16	6
Subsoil (3)	1	8	5	35	27	15	7

	Acres.
Munising area, Mich	7,936

Cumberland loam.—The soil is a brown rather mellow loam or slightly sandy loam 6 to 15 inches deep, underlain by a brown to reddish-brown clay loam subsoil. Some rounded gravel occurs in both soil and subsoil. The type occupies second bottoms or high terraces along streams, occurring mainly in the horseshoe bends. The surface is generally rolling and the drainage excellent. This is a sedimentary soil made up of materials washed from the adjacent uplands, intermingled with materials brought from a greater distance by the river. It is well suited to general farm crops and is also used for truck crops, small fruits, and orchards.

	1	2	3	4	5	6	7
Soil (4)	1	3	5	17	21	41	12
Subsoil (4)	0	2	4	13	18	41	22

	Acres.
Davidson County, Tenn	44,992
Madison County, Ky	4,288
Greeneville, Tenn	7,040

Conestoga loam.—The soil is a brown loam about 12 inches deep, underlain by a light clay loam to a depth of 30 inches, grading into decomposed schist. The type occupies rolling valley land, and is derived from the decomposition of schistose limestone. It has a greasy or soapy feel when rubbed between the fingers. This is recognized as an excellent soil for general agriculture.

	1	2	3	4	5	6	7
Soil (2)	2	2	2	8	22	50	11
Subsoil (2)	1	3	2	9	26	45	13

	Acres.
Lancaster County, Pa	51,000
Montgomery County, Pa	1,344

Gasconade silt loam.—The soil consists of from 8 to 12 inches of dark-gray to black silt loam. The subsoil is a heavy mottled silt loam, grading below 36 inches into a gray and red mottled silty clay. The subsoil rests in some places upon unweathered limestone at a depth of 4 to 6 feet. The type is found upon gently rolling prairie uplands and has excellent drainage. It is a residual type derived from limestone.

The soil is productive and is nearly all under cultivation. Corn yields from 20 to 45 bushels per acre, and wheat, timothy, and clover do well.

	1	2	3	4	5	6	7
Soil (1)	0	2	1	3	3	67	24
Subsoil (1)	3	2	2	3	1	58	35

	Acres.
Crawford County, Mo	1,600

Fort Payne clay loam.—The soil is a compact loam to silty loam with an average depth of 10 inches and an ashy appearance and feel. The color ranges from gray to light yellow. The subsoil is a heavy yellow clay loam, grading quickly into stiff, sticky, impervious yellow clay, which in the lower depths is often mottled with red. The type occupies high hilly to gently rolling areas. It is a residual type, derived from the weathering of a series of rocks consisting of sandy to argillaceous calcareous shales, shaly limestone, and impure limestones. The soil is difficult to work and when dry is very hard. It is probably best suited to grasses and pasturage.

	1	2	3	4	5	6	7
Soil (2)	6	5	2	6	10	53	18
Subsoil (2)	1	1	1	3	4	34	56

	Acres.
Greeneville area, Tenn	9,536

Lickdale clay loam.—This is a clay loam 6 to 10 inches deep, underlain by a mottled yellow clay. It occurs in small areas at the foot of the Blue Ridge Mountains, and is derived from the wash of the mountains and the adjacent shale formations. Sometimes fragments of gray sandstones are present to the extent of from 5 to 20 per cent. It is a low-lying, flat land, and is poorly drained. Naturally it is very refractory, and is suited only to grass and pasture, but when artificially drained it becomes mellow and produces quite a wide range of crops.

	1	2	3	4	5	6	7
Soil (5)	0	3	5	6	8	48	29
Subsoil (5)	2	2	5	5	6	38	42

	Acres.		Acres.
Chester County, Pa	832	Montgomery County, Pa	2,240
Lebanon Pa	3,920	Pikeville, Tenn	[a] 17,024
Lockhaven, Pa	1,984		

Murrill clay loam.—The soil is a yellowish-brown clay loam 10 inches deep, overlying a yellow clay loam, which increases in clay content

[a] Mapped as Dekalb clay loam.

in lower depths. Both soil and subsoil often contain small fragments of shale and chert. The type is derived from weathering of shales and cherty limestone, and occupies rolling valley lands. The soil produces good crops of wheat, corn, grass, dark manufacturing tobacco, and apples.

	1	2	3	4	5	6	7
Soil (3)	3	6	4	9	7	43	28
Subsoil (3)	3	5	4	8	5	30	44

	Acres.
Bedford, Va	15,720

Conestoga clay.—This type consists of a yellowish to dark-brown clay loam about 7 inches deep, underlain by a yellow to reddish-yellow tenacious clay, usually not exceeding a depth of 24 inches. On ridges bed rock is usually found at an average depth of 10 inches. The type occupies the lower and gently rolling portions of the valleys. The higher areas are well drained. This is a residual soil derived from schistose limestone. Wheat and grass are the principal crops grown.

	1	2	3	4	5	6	7
Soil (4)	3	4	2	3	4	43	41
Subsoil (3)	1	3	2	3	2	37	51

	Acres.
Albemarle, Va	16,960
Greeneville, Tenn	[a] 47,168

Guthrie clay.[b]—The soil is a light-gray or grayish-white fine silt loam, having a depth of 7 inches, underlain by a heavy silty clay, plastic and impervious. The subsoil varies in color from gray to drab, mottled with yellowish iron stains. The type occupies low, flat areas on the uplands. The soil is derived from the decomposition of limestone. On account of its low, wet situation it is of little agricultural value unless artificially drained. In favorable seasons some corn and tobacco are grown. The type is largely covered by hickory, sweet gum, and oak, and the land is generally referred to as "crawfishy."

	1	2	3	4	5	6	7
Soil (6)	0	1	1	4	6	68	20
Subsoil (6)	0	1	1	4	4	56	33

	Acres.		Acres.
Huntsville, Ala	10,048	Madison County, Ky	4,480
Lauderdale County, Ala	5,376	Stuttgart, Ark	27,904
Montgomery County, Tenn	5,800		

[a] Mapped as Fort Payne clay.

[b] See also Waverly clay loam, p. 89.

SOILS OF THE GLACIAL AND LOESSIAL REGIONS.

The soils of the glacial part of the country constitute one of the most important groups of soils found in the United States. This group includes all soils derived directly from till or loess. The soils formed from the till are confined to that part of the country lying north of the southern limit of glacial action, but the loess soils occur also south of this line, especially along the Mississippi and Ohio rivers, and in Kansas and Nebraska. The line of the southern extension of the ice sheet touches the Atlantic coast about New York City, passes through northern New Jersey, southern New York, and northwestern Pennsylvania, swings southwestward through Ohio to Cincinnati, crosses the Mississippi River at St. Louis, and follows the south side of the Missouri River into Montana, where it crosses the Canadian boundary line, then dips southward into Idaho as a long lobe in the mountainous non-agricultural region, and crosses the northwestern part of Washington, including the Puget Sound region.

Practically all of the United States north of this line was covered in recent geological time by a great continental glacier, many hundreds, and even thousands, of feet in thickness. This great ice sheet, moving in a southern direction, filled up valleys, planed off the tops of hills and mountains, ground up the underlying rocks, carried the derived material both within and upon the ice, and finally deposited the gravel, sand, silt, and clay as a mantle, varying in thickness from a few feet to more than 300 feet. Often this material has been transported hundreds of miles, and is wholly unrelated to the underlying rocks, but in some places the movement has been slight and the drift consists very largely of the ground-up underlying rock. Over a large proportion of the area covered by the drift and also along the Ohio and Mississippi rivers and in Kansas and Nebraska the surface material consists of a fine silty deposit, known geologically as "loess" and "plains marl." In the classification of the glacial soils three important series—Miami, Marshall, and Volusia—having distinct characteristics have been recognized, and, in addition, quite a number of local soils which can not be put in any series.

MIAMI SERIES.

The Miami series is one of the most important, widely distributed, and complete soil series that has been established. The series is characterized by the light color of the surface soils, by derivation from glacial material, and by being timbered either now or originally. The heavier members of the series are better adapted to wheat than the corresponding members of the Marshall series, but they do not produce as large yields of corn.

Miami stony sand.—The soil is a loose yellow or brown sand or light sandy loam 8 inches deep, underlain by yellow sand of varying texture to a depth of 3 feet or more. Stones and large bowlders, constituting from 20 to 70 per cent of the total mass, are scattered on the surface and mixed with the soil and subsoil. The type is derived from morainic material and occupies large, rounded hills and ridges. Corn, rye, and buckwheat are grown to some extent, but the yields are low.

	1	2	3	4	5	6	7
Soil (4)	12	24	17	18	8	13	8
Subsoil (3)	10	21	15	26	9	13	6

	Acres.		Acres.
Allegan County, Mich	[a] 4,150	Pontiac, Mich	[a] 1,472
Island County, Wash	71,744	Portage County, Wis	17,536
Long Island, N. Y	[a] 5,376		

Miami stony sandy loam.—The soil is a gray or brown sandy or fine sandy loam from 6 to 10 inches deep, underlain by a brown or yellow sandy loam or heavy sandy loam. Both soil and subsoil contain from 20 to 70 per cent of stones and gravel, consisting of granite, sandstone, and limestone. The type is derived from the weathering of glacial material, occupies the rolling and level uplands, and is usually well drained. The soil is not very productive. Beans, corn, wheat and oats, and grasses are the main products. Truck and fruit do fairly well.

	1	2	3	4	5	6	7
Soil (11)	4	11	8	19	20	25	13
Subsoil (11)	5	10	8	20	19	25	13

	Acres.		Acres.
Island County, Wash	25,792	Rhode Island	[b] 69,952
Long Island, N. Y	[b] 100,608	Syracuse, N. Y	[b] 3,712
Lyons, N. Y	[b] 38,208	Vergennes, Vt.-N. Y	[b] 29,056

Miami stony loam.—The soil consists of a gray to brown loam about 10 inches deep, underlain by a yellow loam or heavy sandy loam, which is in turn underlain locally by beds of consolidated gravel or bed rock. There is from 20 to 60 per cent of rounded and angular

[a] Mapped as Plainwell stony loam.
[b] Mapped as Alton stony loam.

stones on the surface and mixed with both the soil and subsoil. The stones vary from 1 to 8 inches in diameter. The type generally occupies large, rounded hills and table-lands and gently rolling lands at lower levels. It is chiefly derived from morainic material. The soil is very productive, and produces good crops of corn, wheat, grass, oats, and fruit, particularly apples. The type also affords excellent pasture.

	1	2	3	4	5	6	7
Soil (18)	2	4	4	10	16	47	17
Subsoil (17)	2	4	4	11	16	43	20

	Acres.		Acres.
Allegan County, Mich	[a] 76,790	Lyons, N. Y	158,400
Auburn, N. Y	114,624	Portage County, Wis	5,632
Carlton, Minn	50,560	Rhode Island	149,952
Cleveland, Ohio	8,000	Syracuse, N. Y	78,464
Everett, Wash	23,488	Tompkins County, N. Y	7,488
Long Island, N. Y	52,032	Wooster, Ohio	52,096

Miami gravel.—The soil is a medium grade sandy loam about 12 inches deep, containing 50 per cent of gravel from one-half inch to 2 inches in diameter. The subsoil consists of cross-bedded sand and gravel, the latter often coated with calcium carbonate. The type occurs only in small areas and is the outcrop of reworked glacial gravels in river cliffs. For the most part, it is uncultivated and is of little value for farming.

	Acres.
Janesville, Wis	[b] 9,024
Tazewell County, Ill	[b] 1,088
Winnebago County, Ill	5,184

Miami gravelly sand.—The soil is a brown gravelly sand of medium to coarse texture, 9 to 12 inches deep, grading through a lighter brown gravelly sand into a mixture of coarse sand and fine gravel at a depth of about 3 feet. In some places the underlying gravel comes within a few inches of the surface. The type represents mainly old beach lines, and is formed by material deposited by wave or stream action. Its usually rolling or ridgy topography insures good drainage. The type is best suited to truck and fruit crops.

[a] Mapped as Allegan stony loam.
[b] Mapped as Mackinaw gravel.

	1	2	3	4	5	6	7
Soil (1)	5	20	24	30	6	10	5
Subsoil (1)	5	24	25	29	5	7	5

	Acres.		Acres.
Allegan, Mich	[a] 4,810	Oxford, Mich	3,968
Alma, Mich	5,504	Pontiac, Mich	[b] 15,104
Island County, Wash	33,600	Saginaw, Mich	14,176
Owosso, Mich	14,080		

Miami gravelly sandy loam.—The soil to a depth of 8 inches is generally a light-brown sandy loam containing a high percentage of gravel and frequently small stones. The subsoil varies from a sticky sandy loam to a gravelly sand, and is often underlain at a depth of 2 to 3 feet by a bed of gravel. The surface is rolling and the type often occurs as rounded knolls or hills, generally composed of stratified and unstratified sands, clays, and gravel. It is of glacial origin, and often represents morainic material. Where cultivated, the crop yields are only fair. It is not adapted to general farming, though fairly well adapted to light farming and the production of small fruits. In favorable localities peaches do well on this soil.

	1	2	3	4	5	6	7
Soil (2)	4	14	14	23	11	24	10
Subsoil (2)	6	18	15	26	7	16	12

	Acres.		Acres.
Carlton, Minn	5,184	Oxford, Mich	9,472
Everett, Wash	23,360	Pontiac, Mich	[a] 6,912
Marshall County, Ind	1,216	Tippecanoe County, Ind	1,024

Miami gravelly loam. [c]—The soil is a brown or reddish loam 12 inches deep, containing 15 to 30 per cent of rounded gravel. The soil is underlain to a depth of 24 inches by a stiff tenacious clay loam, which is in turn underlain by gravel. The type occupies level or gently rolling river terraces, and is composed of original glacial material worked over by the streams. This is recognized as a fine soil for general farm purposes.

	1	2	3	4	5	6	7
Soil (9)	5	11	8	10	7	44	20
Subsoil (14)	5	11	8	11	11	31	22

	Acres.		Acres.
Columbus, Ohio	18,944	Pontiac, Mich	1,088
Coshocton County, Ohio	15,104	Westerville, Ohio	3,136
Montgomery County, Ohio	24,000	Wooster, Ohio	8,384

[a] Mapped as Allegan gravelly loam.
[b] Mapped as Marshall gravel.
[c] See also Dunkirk gravelly loam, p. 151.

Miami sand.—The soil is a coarse to medium loose, incoherent sand, underlain by yellow or reddish sand of about the same texture. This is the prototype of the Norfolk sand of the Atlantic coast and Fresno sand of the Pacific coast, and is a typical truck soil. The type may be either of glacial or alluvial origin, modified by wind action, and has a level or rolling topography.

	1	2	3	4	5	6	7
Soil (32)	2	13	24	42	8	6	4
Subsoil (30)	2	14	27	42	6	5	4

	Acres.		Acres.
Allegan County, Mich	[a]117,480	Portage County, Wis	146,624
Alma, Mich	33,472	Posey County, Ind	7,680
Carlton, Minn	17,408	Saginaw, Mich	52,000
Grand Island, Nebr	29,440	Superior, Wis	4,608
Marshall County, Ind	27,840	Toledo, Ohio	36,672
Munising, Mich	166,464	Viroqua, Wis	28,288
Oxford, Mich	5,504	Wichita, Kans	19,392
Owosso, Mich	3,712	Wooster, Ohio	2,432
Pontiac, Mich	30,592		

Miami fine sand.—The soil is a fine yellow or light-brown sand 6 to 12 inches deep. The subsoil consists of a fine orange or yellow sand. The type is free from stones and often occurs as dunes. It has good natural drainage and is easily tilled. The principal crops are corn, potatoes, berries, and, of less importance, wheat, oats, grasses, and cabbage. The soil is best adapted to truck, potatoes, and small fruit.

	1	2	3	4	5	6	7
Soil (36)	0	4	13	50	18	10	5
Subsoil (30)	0	4	13	49	20	9	5

	Acres.		Acres.
Allegan County, Mich	[b]13,260	Saginaw, Mich	36,608
Auburn, N. Y	1,920	Sangamon County, Ill	1,024
Carlton, Minn	1,920	Stanton, Nebr	56,576
Dubuque, Iowa	2,624	Syracuse, N. Y	14,528
Janesville, Wis	[c]16,256	Tama County, Iowa	3,968
Lyons, N. Y	14,656	Tazewell County, Ill	22,976
Newton County, Ind	32,704	Tippecanoe County, Ind	2,816
O'Fallon, Mo	1,728	Wichita, Kans	15,744
Owosso, Mich	7,808	Winnebago County, Ill	8,832

[a] Mapped as Allegan sand.

[b] Mapped as Allegan fine sandy loam. Part of this should have been mapped as Clyde fine sand.

[c] Mapped as Afton fine sandy loam.

Miami sandy loam.[a]—The soil is light-gray to brown sandy loam 8 to 14 inches deep, underlain by a sandy loam or sand, sometimes containing fine gravel. The type is of glacial origin and occupies level or gently rolling areas, and sometimes rounded hills with kettle-like intervening depressions. In some areas the soil is adapted to corn, wheat, grass, rye, and oats; in others mainly to fruits, small fruits, and truck crops.

	1	2	3	4	5	6	7
Soil (22)	2	12	19	30	10	19	8
Subsoil (22)	2	11	18	30	14	16	8

	Acres.		Acres
Allegan County, Mich	[b]60,020	Pontiac, Mich	34,368
Carlton, Minn	54,784	Portage County, Wis	65,536
Dubuque, Iowa	15,040	Superior, Wis	105,536
Everett, Wash	184,320	Toledo, Ohio	30,528
Janesville, Wis	[c]11,648	Viroqua, Wis	16,064
Munising, Mich	39,552	Wooster, Ohio	11,712
Oxford, Mich	35,584		

Miami fine sandy loam.[d]—The soil consists of a loose, loamy brown sand or sandy loam from 10 to 30 inches deep, the sand being from medium to fine in texture. The subsoil is a clay loam or sticky sandy loam. This type differs from the Miami sandy loam in having the heavy subsoil within 3 feet of the surface. The type is of glacial origin, occupies rolling country, often occurring as rounded hills and ridges, and has good drainage. The Miami fine sandy loam is a good corn soil. Wheat yields from 15 to 30 bushels, oats from 35 to 75 bushels, rye from 15 to 30 bushels, and hay $1\frac{1}{2}$ to 2 tons per acre. The soil is used for general agriculture, but is especially adapted to medium and late truck crops and fruit.

	1	2	3	4	5	6	7
Soil (9)	2	6	10	27	14	28	13
Subsoil (9)	2	5	6	20	12	29	26

	Acres.		Acres.
Alma, Mich	34,432	Pontiac, Mich	[e]25,984
Owosso, Mich	2,624	Saginaw, Mich	10,048
Oxford, Mich	44,224	Tippecanoe County, Ind	4,608

[a] See also Clyde fine sandy loam, p. 157, Wabash fine sandy loam, p. 85, and Wabash sandy loam, p. 84.

[b] Mapped as Allegan sandy loam.

[c] Mapped as Hanover sand.

[d] See also Dunkirk fine sandy loam, p. 152, Memphis silt loam p. 175, Norfolk fine sandy loam, p. 51, and Waverly fine sandy loam, p. 88.

[e] Mapped as Oakland sandy loam.

Miami loam.[a]—The soil consists of a light-brown to dark-gray rather mellow loam about 12 inches deep, sometimes becoming lighter in color with depth. The subsoil is a compact yellow sandy clay, frequently carrying stones and gravel. Often at a depth of from 14 to 25 inches gravelly material is encountered. A few bowlders and pebbles usually are found on the surface. The type occupies level to rolling upland, and is fairly well drained except in some of the level areas. The soil is especially suited to corn and potatoes, while small grain and grass are grown with a fair degree of success. Small fruits, such as strawberries and raspberries, do well.

	1	2	3	4	5	6	7
Soil (5)	2	12	11	11	6	44	14
Subsoil (5)	2	13	12	15	8	30	20

	Acres.		Acres.
Portage County, Wis	44,544	Tippecanoe County, Ind	1,920

Miami silt loam.[b]—This is a light-brown or yellow to almost white silt loam from 8 to 12 inches deep, underlain by a compact silt loam or silt clay of a yellowish color. The type occupies rolling to hilly areas and was originally timbered. Its origin is due to the deposition of loess over glacial till. The soil is not as productive as the Marshall silt loam, but produces good yields of wheat, corn, clover, and timothy hay.

	1	2	3	4	5	6	7
Soil (41)	0	1	1	2	8	73	15
Subsoil (40)	0	1	1	1	7	71	19

	Acres.		Acres.
Boonville, Ind	86,656	Saline County, Mo	43,776
Clinton County, Ill	[c]9,920	Sangamon County, Ill	92,416
Dubuque Iowa	[d]176,896	Sarpy County, Nebr	69,696
Janesville, Wis	[c]81,216	Tama County, Iowa	76,224
Knox County, Ill	135,552	Tazewell County, Ill	[e]224,960
McLean County, Ill	58,368	Tippecanoe County, Ind	41,288
O'Fallon, Mo	54,656	Union County, Ky	154,176
Posey County, Ind	149,376	Viroqua, Wis	201,408
Rhode Island	4,928	Winnebago County, Ill	62,464

[a] See also Sioux loam, p. 161, Sioux sandy loam, p. 160, and Wabash loam, p. 85.

[b] See also Dunkirk silt loam, page 153, and Marshall silt loam, page 144.

[c] Mapped as Edgerton silt loam.

[d] Part of this should have been mapped as Marshall silt loam. At the time the differences between the soils locally known as the "clay land" and the "dark loam" did not appear sufficient to justify a separation into two types, but with wider experience in soils of this class, it appears that the latter soil should have been mapped as Marshall silt loam.

[e] Mapped as Tazewell silt loam. This soil should have been mapped in part as Miami silt loam and in part as Marshall silt loam.

Miami black clay loam.—*(For description see under Marshall series, page* 145.)

Miami clay loam.[a]—The soil to an average depth of 10 inches consists of a yellowish-gray to light-brown somewhat silty loam, underlain by light-brown to yellow, sometimes mottled, stiff silty clay loam or clay, which is in turn underlain by bowlder clay at depths varying from 5 to 10 feet. Stones and erratic bowlders are found on the surface, but in no great quantity except in small areas. The type occupies uplands and the surface is level to gently rolling, except near streams, where it becomes hilly and broken. The flat interstream areas generally require artificial drainage. The soil is fairly good for general farming, and is especially adapted to small grains and grass crops.

	1	2	3	4	5	6	7
Soil (31)	2	4	5	14	10	44	21
Subsoil (33)	1	3	4	11	10	38	33

	Acres.		Acres.
Allegan County, Mich	[b] 107,850	Owosso, Mich	62,464
Alma, Mich	6,144	Oxford, Mich	12,160
Cleveland, Ohio	243,456	Pontiac, Mich	56,384
Columbus, Ohio	222,336	Saginaw, Mich	26,240
Island County, Wash	2,240	Story County, Iowa	13,376
Madison County, Ind	232,640	Westerville, Ohio	267,264
Marshall County, Ind	3,392	Wooster, Ohio	116,160
Montgomery County, Ohio	240,000		

MARSHALL SERIES.

The Marshall series includes the dark-colored upland glacial and loessial soils, which cover almost all of the great prairie region of the Central West. The soils of this series are characterized and distinguished from those of the Miami series by the greater quantity of organic matter in the surface soils, which gives them a dark-brown to black color. The topography is level to rolling, and artificial drainage is usually necessary to secure the best results. The soils of this series are very productive and constitute the great corn soils of the country.

Marshall stony loam.—The soil is a dark-brown to black loam or sandy loam 8 inches deep, containing considerable gravel and small stones, underlain by a yellow clay loam mixed with gravel and sand.

[a] See also Dunkirk clay loam, page 153; Crowley silt loam, page 79.

[b] Mapped as Allegan clay, which name will not be used hereafter.

Very little of the type is under cultivation. It is used mainly for grazing, to which it is well adapted.

	1	2	3	4	5	6	7
Soil (7)	3	7	7	19	16	34	14
Subsoil (5)	4	7	7	16	12	31	22

	Acres.
Brookings, S. Dak	8,256
Carrington, N. Dak	23,936
Jamestown, N. Dak	30,208

Marshall gravel.[a]—The soil is a dark-brown to black sandy loam, containing a high percentage of fine gravel. At 15 to 24 inches it grades into a bed of gravel and coarse sand. With the exception of some pasturage afforded early in the season it has little agricultural value, the crops being small and easily affected by drought.

	1	2	3	4	5	6	7
Soil (2)	8	20	14	17	5	26	10
Subsoil (2)	13	28	17	13	4	15	11

	Acres.
Cando, N. Dak	1,344
Marshall, Minn	1,216

Marshall gravelly loam.—The soil consists of about 12 inches of heavy black sandy loam, underlain by 2 feet of coarse gravel usually resting on a coarse sand extending to a depth of 6 feet or more. The gravel is limestone, crystalline rock fragments, or shale. This is a glacial soil, usually representing beaches along old glacial lakes. This type usually occurs in narrow bands. Except in very wet seasons the crop yields are very light.

	1	2	3	4	5	6	7
Soil (9)	5	10	7	14	12	32	20
Subsoil (10)	7	14	10	18	10	23	18

	Acres.		Acres.
Brown County, Kans	10,176	Grand Forks, N. Dak	[b]51,136
Carrington, N. Dak	1,920	Marshall, Minn	960
Fargo, N. Dak	2,688	Portage County, Wis	24,064

Marshall sand.—The soil consists of a dark-brown to black sand, coarse to medium in texture, with an average depth of 10 to 12 inches. It is underlain by a coarse to medium sandy subsoil, lighter colored than the soil. The soil possesses quite a marked loamy texture,

[a] See also Miami gravelly sand, page 135.

[b] Mapped as Fargo gravelly loam.

particularly in depressions, owing in part to the admixture of fine silt and clay particles, but chiefly because of the presence of a considerable proportion of organic matter. The type occupies narrow ridges, and is characterized by a somewhat hummocky topography. The soil material is of glacial origin, modified by wind action. Crop yields are uncertain, but are larger in wet seasons than in dry. The soil is well adapted to vegetables and melons where moisture conditions are favorable or can be controlled.

	1	2	3	4	5	6	7
Soil (3)	2	12	26	42	5	6	7
Subsoil (3)	1	11	25	46	4	6	6

	Acres.
Cerro Gordo County, Iowa	1,024
Marshall County, Ind	20,672
Portage County, Wis	31,040

Marshall fine sand.—The soil is a dark-brown to black rather incoherent sand of fine texture, 10 to 12 inches deep, resting on a lighter colored sand of about the same texture. The type occupies low bluffs and hills. The surface is broken and rolling, and the drainage is apt to be excessive, especially where the sandy subsoil is deep. The origin of the type is primarily glacial. The crop value varies greatly, depending mainly upon the condition as regards moisture. The soil is best adapted to early truck crops and melons. It also produces, with the aid of liberal manuring, very good yields of Irish potatoes.

	1	2	3	4	5	6	7
Soil (7)	1	3	9	52	20	9	7
Subsoil (7)	0	2	9	56	20	7	6

	Acres.		Acres.
Carrington, N. Dak	4,096	Newton County, Ind	9,792
Kearney, Nebr	21,440	Story County, Iowa	3,072

Marshall sandy loam.—The soil is a dark-brown to black compact sandy loam, about 10 inches in depth, resting on 6 inches of yellowish loam, only less sandy than the surface soil, which is in turn underlain at from 16 to 36 inches below the surface by yellowish clay containing a high percentage of coarse sand and gravel. Rounded pebbles and bowlders occur on the surface, while in the subsoil partly decomposed calcareous nodules are found. The type occupies gently rolling prairie ridges and intervening depressions and is mainly of glacial origin. This is a good general farming soil, although in some local areas it is inclined to be droughty. Wheat yields from 12 to 20 bushels oats from 20 to 35 bushels, flax from 12 to 15 bushels, and potatoes from 100 to 125 bushels per acre.

	1	2	3	4	5	6	7
Soil (12)	2	10	14	28	11	24	11
Subsoil (14)	2	9	14	23	14	23	18

	Acres.		Acres.
Brookings, S. Dak	93,376	Marshall, Minn	[a] 4,480
Brown County, Kans	2,240	Winnebago County, Ill	[b] 84,160
Marshall County, Ind	77,184		

Marshall fine sandy loam.—The soil consists of dark-brown to black medium to fine sandy loam, with an average depth of 14 inches. It contains a high percentage of organic matter, but this decreases with depth, as does also the dark color. The subsoil is somewhat variable, but typically consists of a yellow medium to fine sandy loam containing considerable clay, which gradually becomes heavier with depth, grading into a mottled yellow, sticky sandy clay, which in turn is underlain by bowlder clay at a depth of 3 or 4 feet. Occasionally layers of sand are encountered in the subsoil. The type is derived from glacial till. Its surface is undulating or rolling and generally affords sufficient drainage. The soil is very productive and has a wide crop adaptation.

	1	2	3	4	5	6	7
Soil (4)	1	6	10	34	15	22	11
Subsoil (5)	1	5	11	37	12	18	15

	Acres.		Acres.
Carrington, N. Dak	21,696	Newton County, Ind	42,560
Kearney, Nebr	15,424	Tippecanoe County, Ind	11,584

Marshall loam.—The soil is a dark-brown to black loam, 10 to 12 inches deep, resting on a lighter colored loam or heavy loam. The deep subsoil consists of clay, sand, gravel, and bowlders mingled together in a disorderly mass. The type is derived from unstratified glacial drift. Glacial bowlders are found here and there on the surface, in some areas so plentiful as to interfere with cultivation. The type occupies gently undulating to rolling country and covers wide areas in the prairies of the Northwest. While extensive areas are well drained and well suited to farming, there are areas of obstructed drainage, resulting in bogs, ponds, and swampy depressions, which

[a] Mapped in part as Fairview sandy loam.

[b] Mapped as Winnebago sandy loam.

are unfit for cultivation without artificial drainage, often a difficult problem. The soil is excellent for general farming purposes. Wheat, oats, corn, barley, and flax are the principal crops.

	1	2	3	4	5	6	7
Soil (21)	1	5	6	18	11	38	20
Subsoil (23)	1	5	6	17	11	35	24

	Acres.		Acres.
Brookings, S. Dak	135,808	Marshall County, Ind	121,216
Cando, N. Dak	79,936	Marshall, Minn	108,352
Carrington, N. Dak	114,560	McLean County, Ill.	[b] 17,984
Cerro Gordo County, Iowa	242,112	Newton County, Ind	81,856
Fargo, N. Dak	7,168	Story County, Iowa	303,808
Grand Forks, N. Dak	[a] 12,352	Tama County, Iowa	1,728
Jamestown N. Dak	206,976	Tippecanoe County, Ind	72,320
Kearney, Nebr	45,568		

Marshall silt loam.—The soil is a dark-brown to black silt loam, 15 inches deep, resting usually on a light-colored, sometimes mottled, silty loam or silty clay. Lime concretions frequently occur. The type varies in topography from level to rolling and hilly, and is derived from loessial deposits. Drainage is generally good but not excessive, the subsoil retaining moisture well and crops resisting drought to a marked degree. This is a fine soil for the production of wheat, corn, oats, alfalfa, tobacco, and sugar beets where climatic conditions are favorable.

	1	2	3	4	5	6	7
Soil (42)	0	1	1	2	9	70	17
Subsoil (40)	0	1	0	2	7	71	19

	Acres.		Acres.
Brown County, Kans	307,264	McLean County, Ill	574,720
Carrington, N. Dak	240,128	Russell County, Kans	[f] 91,648
Clinton County, Ill	[c] 57,472	Saline County, Mo	306,816
East Baton Rouge Parish, La.	16,640	Sangamon County, Ill	332,224
Garden City, Kans	77,120	Sarpy County, Nebr	39,232
Grand Island, Nebr	137,984	Stanton, Nebr	102,720
Jamestown, N. Dak	41,280	St. Clair County, Ill	[c] 106,432
Janesville, Wis	[d] 81,344	Tama County, Iowa	308,288
Kearney, Nebr	322,688	Tippecanoe County, Ind	140,166
Knox County, Ill	289,088	Viroqua, Wis	20,864
Lower Arkansas Valley, Colo.	[e] 236,288	Winnebago County, Ill	90,624

[a] Mapped as Fargo loam.
[b] Mapped as McLean silt loam.
[c] Mapped as Miami silt loam.
[d] Mapped as Janesville silt loam.
[e] Mapped as Fresno fine sandy loam.
[f] Mapped as Sedgwick clay loam.

Marshall clay loam.—The soil is a dark-brown to black clay loam, underlain by a dark-brown clay loam which becomes a very stiff yellow clay at about 24 inches below the surface. When moist, the soil is plastic, and feels smooth when rubbed between the fingers; when dry, it becomes mellow and friable. This type occupies level or gently rolling prairie uplands. The drainage is generally good. In adaptation this soil is a general farming type, corn, oats, and grass being the leading products. It is an ideal corn and hay soil, the yields per acre varying from 25 to 60 bushels of the former and from 1 to 4 tons of the latter. Bluegrass makes a luxuriant pasture, the sod being very permanent. Fruit and vegetables also produce well.

	1	2	3	4	5	6	7
Soil (5)	1	4	5	10	9	41	30
Subsoil (5)	1	5	5	10	11	39	30

	Acres.
Cerro Gordo County, Iowa	67,456
Story County, Iowa	8,384

Miami black clay loam.[a]—The soil is a black clay loam [b] 10 to 12 inches deep, underlain by a tenacious drab clay. The type is of glacial origin, is generally level, and the natural drainage is poor. When thoroughly drained this soil is very productive, particularly for corn. It is also well adapted to grass and wheat.

	1	2	3	4	5	6	7
Soil (37)	0	3	4	9	10	51	22
Subsoil (41)	0	2	2	6	8	55	26

	Acres.
Brookings, S. Dak	43,456
Cerro Gordo County, Iowa	4,032
Columbus, Ohio	33,792
Fargo, N. Dak	74,880
Grand Forks, N. Dak	44,352
Jamestown, N. Dak	5,120
Janesville, Wis	1,856
Knox County, Ill	4,928
McLean County, Ill	70,144
Madison County, Ind	31,360
Marshall County, Ind	1,536
Marshall, Minn	29,760
Montgomery County, Ohio	18,000
Newton County, Ind	1,792
Oxford, Mich	1,216
Pontiac, Mich	11,840
Sangamon County, Ill	88,128
Story County, Iowa	21,952
Tazewell County, Ill	61,184
Tippecanoe County, Ind	3,840
Westerville, Ohio	16,128

[a] See also Clyde clay, p. 158, and Clyde loam, p. 157.

[b] This soil belongs to the Marshall series and should have been called the Marshall black clay loam, but owing to the extensive use of the name the term Miami black clay loam will still be used in all areas.

Marshall clay.—The soil is a heavy black clay loam 18 to 24 inches deep, resting on a grayish-brown clay extending to a depth of more than 3 feet. The subsoil when exposed to the air breaks up into thin flakes resembling shale or slate. The type occupies large areas in the valley of the Red River. The soil is a lacustrine deposit, modified by the addition of river sediments. The drainage is not naturally very good, but has been assisted by the construction of road ditches. This is a very strong soil, well adapted to wheat, oats, barley, flax, and corn.

	1	2	3	4	5	6	7
Soil (3)	0	4	5	10	10	41	30
Subsoil (3)	0	0	0	2	3	44	51

	Acres.
Fargo, N. Dak	76,800

VOLUSIA SERIES.

The soils of the Volusia series are derived from the feeble glaciation of the shales and sandstones of the Devonian and the Upper Carboniferous rocks of eastern Ohio, southern New York, and northern Pennsylvania. In all cases the underlying shales and sandstones have given rise to a large proportion of the soil material, and this has been modified to a varying degree by glacial material brought in from other regions.

Topographically the soils of the Volusia series occupy the upland portion of the plateau country which slopes north and west from the Allegheny Mountains. In the higher, more easterly portions of the glaciated section of the plateau deep preglacial erosion has cut the upland into blocky rounded or flat-topped hills separated by deep, steep-sided gorges. Farther west, where the elevations are less, this topographic feature is not so pronounced and the series occupies rolling hills divided by deep valleys. Under cultivation all of the soils of the series are well adapted to the production of timothy and small grains, particularly oats and buckwheat. At lower elevations wheat and corn give good yields.

Volusia stony loam.—The soil to an average depth of 9 inches is a dark-brown, rather heavy loam. The subsoil to a depth of about 3 feet consists of a yellow or mottled yellow and gray loam, which becomes more sandy with increasing depth. Both soil and subsoil are filled with flat shale and sandstone fragments. The type is derived from the wash of higher lying areas of Volusia loam or Volusia silt loam carried down and deposited over moraine belts bordering the higher uplands.

It is a good general-purpose farming soil, and where well drained is adapted to apple orcharding.

	1	2	3	4	5	6	7
Soil (1)	3	3	3	7	12	48	24
Subsoil (1)	4	5	4	9	15	46	17

	Acres.
Tompkins County, N. Y.	12,352

Volusia gravelly loam.—The soil to an average depth of 6 inches consists of a light-brown to ash-colored loam, containing a large quantity of broken shale and sandstone fragments and a considerable proportion of small shale chips, besides some round gravel and cobble-stones. The subsoil varies from a yellow loam to a yellow or gray sandy loam. The type is derived from small moraines scattered throughout the Volusia loam or Volusia silt loam areas and occurring in the high valleys in the region in which the Volusia series is found.

	Acres.
Tompkins County, N. Y.	4,608

Volusia loam.—To a depth of about 8 inches the soil of the Volusia loam is a deep brown loam containing a considerable quantity of flat shale and sandstone fragments and a large quantity of finely divided shale chips, popularly called "shale gravel" or "black gravel." The subsoil is a yellow or mottled yellow or gray slightly silty loam. The till may rest either upon the underlying rock or upon deposits of sand or broken shale. Both soil and subsoil contain a large percentage of shale and sandstone fragments. The type is derived through the feeble glaciation of the underlying shales and sandstones. The surface is generally less rolling than that of a greater part of the Volusia silt loam, and for the most part the surface drainage is adequate. The soil is very well adapted to the production of grass, oats, buckwheat, and corn in the less elevated portions. Apples are grown to advantage on this type throughout a considerable part of its extent.

	1	2	3	4	5	6	7
Soil (12)	2	4	3	8	12	44	27
Subsoil (12)	3	6	4	10	12	41	24

	Acres.		Acres.
Ashtabula, Ohio	173,440	Tompkins County, N. Y.	91,328
Auburn, N. Y.	70,720	Westfield, N. Y.	[a] 79,970

[a] Of this 69,910 acres was mapped as Volusia sandy loam.

Volusia silt loam.—The soil of the Volusia silt loam, to an average depth of 8 inches, is a gray to brown silty loam. The subsoil, to a depth of about 2 feet, is a light-yellow silty loam, and below 2 feet it usually becomes mottled with gray or drab. Both soil and subsoil contain a high percentage of flat fragments of shale and sandstone from 6 inches to one or more feet in breadth. In addition a considerable quantity of finely divided shale fragments are found in both soil and subsoil. The subsoil usually rests at a depth of from 18 inches to 3 or 4 feet upon shale or sandstone rock. The type is derived from the weathered products of the shale and sandstone, reworked by glaciation and to a small degree modified by material brought in through glacial action. The type occupies rolling and hilly land and is frequently interrupted or bordered by steep slopes not suited to agricultural purposes. The Volusia silt loam where properly cultivated is a good soil for timothy and small grains. In the eastern part of the region where it occurs it lies at too high an elevation to be well adapted to corn. In this locality buckwheat and potatoes are grown to advantage.

	1	2	3	4	5	6	7
Soil (10)	2	4	1	2	10	59	22
Subsoil (10)	3	4	2	3	10	55	23

	Acres.		Acres.
Binghamton, N. Y	118,976	Tompkins County, N. Y	78,912
Bigflats, N. Y	[a] 108,800	Wooster, Ohio	78,464
Scott County, Ind	46,912		

Volusia clay loam.—The soil to a depth of about 8 inches is a dark-yellow or brown heavy loam or clay loam. The subsoil is a pale-yellow or drab clay loam. Both soil and subsoil contain a considerable quantity of shale and sandstone chips and sometimes larger pieces of stone. Some large erratic bowlders occur but are not abundant. The deep subsoil is locally called "blue clay." The surface is rolling and irregular, and sometimes morainal in character. The type is well adapted to general farming, but is in need of drainage.

	Acres.
Tompkins County, N. Y	5,952

[a] Mapped as Hagerstown shale loam.

SOILS OF THE GLACIAL LAKES AND TERRACES.

Another important group of soils occurs in the glacial region, principally as terraces around lakes, or along streams, or as deposits in areas which were formerly covered by water. At the close of the Glacial Epoch the lakes in this part of the United States were not only more numerous, but the waters of those which remain reached a higher level and covered areas that are now far above their present shore lines. In some cases several distinct terraces, each one marked by an old shore line, are easily discernible and represent successive stages in the lowering of the water level. Their elevation above the lake varies from a few feet to more than 200 feet. The surface of each terrace is usually rolling to level, with a gradual slope toward the lake, but sometimes areas of a rough and broken character occur. The streams which cross these terraces have frequently, by their cutting, produced deep, steep-sided valleys, especially near the lakes.

The soils of this group vary from typical beach gravels to offshore deposits of heavy clays. The material from which they are derived consists of glacial débris reworked and redeposited in the lakes or along streams when their waters stood at a higher level. While this glacial material is made up of rocks of widely varying origin, a large proportion of it often consists of the country rock. In the eastern part of the Great Lake region the percentage of sandstone and shale fragments is usually very high, while in the western part more of the igneous rocks are present. This fact, together with differences in drainage conditions, has given rise to four series of soils: The Dunkirk, Clyde, Vergennes, and Superior. While all of these series, except the Vergennes, are typically developed around the Great Lakes, they also occur around smaller ones, in areas which were formerly lake beds, or along streams in the glacial region.

DUNKIRK SERIES.

The Dunkirk series is an important member of the Glacial Terrace group of soils. The soils have been formed by the reworking of glacial material derived principally from sandstone and shale. This series embraces the light-colored surface soils with drab, gray, and mottled yellow subsoils and occurs principally in the eastern part of the Great Lakes region. The soils are not as productive as those of the Clyde series, but some of them are well adapted to special crops.

Dunkirk stony clay.—The soil, to an average depth of 8 inches, is a compact yellow silty clay loam containing from 10 to 20 per cent of small rounded or angular stones. The subsoil is a brown, yellowish-brown or mottled stiff clay, which becomes very sticky and plastic when wet. The stone content of the subsoil is greater than that of the soil. The type occurs in steeply to gently sloping areas characterized by a series of parallel ridges and gullies. At the maximum elevation the surface is rather flat and the soil deeper. Though there is usually sufficient surface drainage, the underdrainage is retarded by the very compact nature of the subsoil, so that ditching and tiling are necessary. The type is probably derived from an old lake sediment. The soil is excellently adapted to grapes, producing about 4 tons to the acre, and pears and apples also do well. Wheat and grass are profitably grown, the former averaging 20 or more bushels to the acre and the latter from 1½ to 3 tons of hay.

	1	2	3	4	5	6	7
Soil (1)	2	5	3	10	14	42	25
Subsoil (1)	3	5	3	8	10	35	35

	Acres.
Auburn, N. Y	4,096
Tompkins County, N. Y	30,976

Dunkirk shale loam.[a]—The soil is a light-gray loam 10 or more inches in depth, containing considerable silt and fine sand. The subsoil, from 10 to 24 inches below the surface, is of the same texture as the soil, but lighter in color, and contains large quantities of angular shale fragments or bowlders. All general farm crops are grown, but to obtain the best results a liberal application of manure is required.

	1	2	3	4	5	6	7
Soil (6)	5	6	2	6	19	44	18
Subsoil (3)	11	12	4	10	16	31	16

	Acres.
Bigflats, N. Y	[b]8,512
Binghamton, N. Y	1,856
Tompkins County, N. Y	1,224

Dunkirk gravel.—This is a very gravelly soil of old lake beaches, occurring in narrow bands between the lake and uplands. The soil is composed of waterworn fragments of shale and is 6 feet or more deep.

[a] See also Dekalb clay, p. 121.

[b] Mapped as Elmira shale loam.

At present the soil is used extensively for grape culture, but the grapes do not keep so well or bear shipment so well as those grown on Dunkirk clay. The soil is quite droughty and not well suited to other crops.

	1	2	3	4	5	6	7
Soil (4)	30	17	7	6	5	20	13
Subsoil (2)	28	33	16	9	3	6	5

	Acres.
Ashtabula, Ohio	2,880
Westfield, N.Y	4,840

Dunkirk gravelly sandy loam.—The soil is a sandy loam containing from 40 to 60 per cent of small gravel consisting principally of waterworn shale fragments. The soil is underlain at about 3 feet by shale fragments or sand. The type represents reworked glacial material deposited in water along the foot of low ridges on lake forelands and also as terraces in stream valleys. It is well drained and early, and is adapted to market-garden and truck crops. It is not well suited for most general farming crops, but is a good corn soil. Grapes are successfully grown.

	1	2	3	4	5	6	7
Soil (4)	14	18	13	13	6	21	11
Subsoil (4)	14	22	17	15	6	16	8

	Acres.		Acres.
Ashtabula, Ohio	[a] 6,528	Tompkins County, N. Y	12,032
Binghamton, N. Y	5,312	Westfield, N. Y	[a] 7,260

Dunkirk gravelly loam.[b]—The soil varies from a light-brown to brown loam, averaging 10 inches in depth, containing from 20 to 50 per cent of rounded waterworn gravel, principally shale. The subsoil is a yellowish to brown loam usually heavier than the soil, with a somewhat higher gravel content which increases with depth. The type is composed of a reworked glacial deposit occurring as stream and lake terraces. Its position and the porous nature of the subsoil affords thorough drainage. The soil is mellow and easily tilled, the stones seldom being large or numerous enough to offer much resistance to cultivation. Most of the ordinary farm crops do well on this soil, particularly corn and oats. Fruits also do well.

[a] Mapped as Dunkirk gravelly loam.

[b] See also Dunkirk gravelly sandy loam, p. 151.

	1	2	3	4	5	6	7
Soil (8)	5	10	6	12	13	36	18
Subsoil (8)	3	8	7	13	16	37	17

	Acres.		Acres.
Auburn, N. Y	640	Cleveland, Ohio	8,384
Bigflats, N. Y	[a] 15,680	Syracuse, N. Y	[a] 39,424
Binghamton, N. Y	4,864	Tompkins County, N. Y	14,528

Dunkirk fine sandy loam.—The soil is a gray or light-brown fine sandy loam about 10 inches deep, underlain by a yellowish fine sandy loam or fine sand. It occurs on lake forelands and extends up streams as terraces. The surface is gently rolling to hummocky. Parts of the type have been influenced by wind action. The soil is adapted to grapes and is also fair grass land.

	1	2	3	4	5	6	7
Soil (10)	1	2	3	22	35	27	10
Subsoil (7)	0	2	4	29	37	20	7

	Acres.		Acres.
Ashtabula, Ohio	[b] 14,720	Syracuse, N. Y	[c] 19,968
Binghamton, N. Y	832	Tompkins County, N. Y	1,600
Cleveland, Ohio	27,328	Westfield, N. Y	[b] 22,090
Lyons, N. Y	[c] 29,824		

Dunkirk loam.—The soil is a light or dark-brown loam 10 inches deep, generally containing considerable sand, which renders it easy to cultivate. The subsoil is a yellow or light-brown fine sandy loam, usually rather compact, becoming darker in color and heavier in texture with depth. A small quantity of stone occurs in soil and subsoil, but seldom enough to interfere with tillage. The surface is undulating and usually well drained. The type is derived from glacial material, probably in part reworked with residual soil derived from sandstone and arenaceous shale. The soil is desirable for general farm purposes, producing good yields of corn, oats, barley, buckwheat, and potatoes. Fruit, especially apples and pears, and most vegetables do well on this soil.

[a] Mapped as Miami gravelly loam.

[b] Mapped as Dunkirk sandy loam, but now brought into proper place in the series.

[c] Mapped as Miami fine sandy loam.

	1	2	3	4	5	6	7
Soil (2)	1	3	3	16	18	46	13
Subsoil (2)	2	5	4	15	21	38	15

	Acres.
Auburn, N. Y	50,304
Cleveland, Ohio	2,880
Tompkins County, N. Y	12,032

Dunkirk silt loam.—The soil to an average depth of 10 inches consists of a pale yellow to light-brown silt loam. This is underlain by a slightly heavier subsoil of a brown or chocolate color. The type is sedimentary in origin and represents the wash from the higher shale slopes deposited in quiet water. It occupies lake forelands and the higher terraces along streams. The soil is easily tilled and produces good yields of general farm crops, besides berries and tree fruits.

	1	2	3	4	5	6	7
Soil (9)	0	1	1	3	18	59	17
Subsoil (9)	0	0	1	2	18	62	16

	Acres.		Acres.
Bigflats, N. Y	[a] 1,920	Syracuse, N. Y	[b] 41,536
Binghamton, N. Y	4,288	Tompkins County, N. Y	1,344
Lyons, N. Y	[a] 28,096		

Dunkirk clay loam.—The soil is a dark-brown to grayish-brown clay loam to a depth of 8 inches. It is quite stiff and heavy and cracks upon drying. The subsoil is a mottled brown and gray heavy clay loam or clay. Both soil and subsoil are generally free from stones or gravel, although small quantities are sometimes found in local spots. The type occupies gently undulating areas and the slopes of hills, which are sometimes quite abrupt. The drainage is adequate in some locations, but in the nearly level or depressed areas it is often necessary to resort to artificial drainage. On account of its heavy, compact nature the subsoil is almost impervious to water. This soil was formed in part from the finer sediments washed out at the front of the ice sheet during the Glacial epoch. These sediments were probably reworked and intermixed with more or less material derived directly from weathering of the underlying limestone and shale. The soil is well adapted to wheat, and grass and corn also do fairly well. Alfalfa has been successfully grown in some localities. It is well adapted to grapes.

[a] Mapped as Elmira silt loam.

[b] Mapped as Miami silt loam.

	1	2	3	4	5	6	7
Soil (2)	2	4	2	12	14	36	29
Subsoil (2)	2	4	2	10	12	34	35

	Acres.
Auburn, N. Y	35,584
Toledo, Ohio	[a]20,352
Tompkins County, N. Y	7,552

Dunkirk clay.—The soil is a drab or gray clay 6 to 12 inches in depth, underlain by a tenacious mottled clay, beneath which at a depth of 4 to 10 feet occurs the typical bowlder clay. Near ancient beach lines the soil is sometimes underlain by gravel. The type is found upon lake foreland and in upland valleys and is derived from deposition in quiet water. Some areas are poorly drained. The soil is adapted to grapes, grain, and grass.

	1	2	3	4	5	6	7
Soil (12)	1	2	2	6	7	39	43
Subsoil (12)	0	1	1	7	9	40	42

	Acres.		Acres.
Auburn, N. Y	2,880	Lyons, N. Y	[b]16,448
Ashtabula, Ohio	8,192	Syracuse, N. Y	[b]24,832
Cleveland, Ohio	10,688	Westfield, N. Y	23,490

CLYDE SERIES.

The soils of the Clyde series consist of reworked glacial material containing a large percentage of organic matter. The surface soil of this series is of a dark-brown to black color, underlain by gray, drab, or mottled yellow subsoils. The dark color of the surface soil, which is the most distinct characteristic of this series, is due to the accumulation of a large percentage of organic matter under swampy conditions. The soils of the Clyde series may be considered as intermediate between the light-colored Dunkirk soils on the one hand and the Muck and Peat areas on the other. They almost always require drainage; but when this is provided they are very productive.

Clyde stony sandy loam.—The soil is a dark-brown, medium-textured gravelly sandy loam, 18 to 24 inches deep, underlain by a sandy loam or mottled brown clay loam containing a small amount of gravel. A noticeable characteristic of the type is the large number of bowlders strewn over the surface and occurring to a less extent below the surface. These bowlders are mainly of granite, and range from cobbles to

[a] Mapped as Miami clay loam.

[b] Mapped as Alloway clay.

angular fragments 2 or 3 feet in diameter. With these stones removed from the surface the soil is a good friable sandy loam, and produces fairly good crops. The type is of glacial or lacustrine origin, has level to gently rolling topography, and for the most part is fairly well drained. The crops grown are corn, oats, wheat, sugar beets, beans, potatoes, hay, etc.

	1	2	3	4	5	6	7
Soil (2)	2	6	12	43	12	16	9
Subsoil (2)	1	6	12	41	13	16	11

	Acres.
Saginaw, Mich	8,000

Clyde gravelly sand.—The soil is a medium-textured, light to dark brown loamy sand or light sandy loam 10 inches deep, carrying a large percentage of gravel. The subsoil is a rather coarse incoherent gravelly sand, usually grading into a mixture of coarse sand and fine gravel at a depth of from 24 to 30 inches. Clay is often found at from 4 to 8 feet below the surface. The type is generally well drained. The topography varies from gentle slopes to gently rolling ridges representing old beach lines or terraces. The soil is the result of beach or shallow water deposition, in places influenced to some extent by local wash from the higher lands. Fairly good yields of corn, oats, wheat, rye, timothy, clover, and buckwheat are secured, and some special crops, such as sugar beets, beans, and potatoes, are grown. The soil is also adapted to fruit and truck crops.

	1	2	3	4	5	6	7
Soil (2)	3	15	20	36	7	10	9
Subsoil (2)	2	16	26	38	5	5	7

	Acres.
Allegan County, Mich	[a] 14,160
Saginaw, Mich	10,496

Clyde gravelly sandy loam.—The soil to a depth of from 8 to 15 inches is a coarse to medium black sandy loam, rich in organic matter and containing a varying percentage of gravel. The subsoil to a depth of 36 inches consists of a mixture of medium to coarse sand, with a high percentage of gravel. The surface varies from nearly level to gently rolling and the drainage is good. This soil has been formed by the reworking of glacial material by water and its deposition in lakes. It is well

[a] Mapped as Kalamazoo gravelly loam.

adapted to potatoes and produces fair crops of grain, hay, onions, carrots, and sugar beets.

	1	2	3	4	5	6	7
Soil (1)	14	30	11	10	5	10	18
Subsoil (1)	4	26	29	30	4	2	4

	Acres.
Island County, Wash	5,952

Clyde sand.—The soil consists of 12 inches of black medium to fine loamy sand, underlain by sand to a depth of 30 inches, which in turn is generally underlain by clay. The type occupies low, flat areas and is generally swampy and poorly drained. It is composed of reworked glacial sands with the addition of organic matter. When well drained, the soil produces good crops of corn, wheat, grass, oats, rye, and all kinds of truck crops. It is a fair soil for sugar beets.

	1	2	3	4	5	6	7
Soil (6)	1	6	23	47	8	9	5
Subsoil (7)	1	9	30	47	5	4	3

	Acres.		Acres.
Allegan County, Mich	38,600	Pontiac, Mich	2,880
Alma, Mich	10,368	Saginaw, Mich	14,656

Clyde fine sand.—The soil consists of a dark-gray to black fine sand varying in depth from 4 to 20 inches. The subsoil has about the same texture as the soil, but contains less organic matter and is lighter in color. In some instances the subsoil contains layers of peat. The surface of the type is nearly level and natural drainage is generally poor. The type has been formed by the reworking of glacial sands and their deposition in former lakes. The soil is greatly improved by artificial drainage. The crop value of this soil depends much upon the proportion of organic matter present and its drainage conditions. It is suited to small fruits, being an ideal soil for strawberries. Fair crops of corn, oats, and potatoes are produced.

	1	2	3	4	5	6	7
Soil (2)	0	2	10	60	9	13	6
Subsoil (2)	0	2	12	69	7	5	5

	Acres.
Newton County, Ind	61,056

Clyde sandy loam.—The soil is a dark-gray or brown medium-textured sandy loam from 8 to 12 inches deep, resting on material of similar texture, but lighter color, which is underlain at 18 inches by a drab or brownish mottled sandy clay, sometimes tending more toward a sticky sandy loam. The soil carries a fair percentage of organic matter and is easily brought into good tilth. The type has been formed by the reworking of glacial material as beach or shallow-water deposits. The surface is level to gently rolling, and upon the whole the drainage features are fairly good. This is a good soil for general farm crops, sugar beets, beans, potatoes, and orchard fruit.

	1	2	3	4	5	6	7
Soil (6)	2	10	13	32	12	18	12
Subsoil (5)	2	9	13	24	10	19	23

	Acres.
Alma, Mich	13,696
Island County, Wash	1,792
Saginaw, Mich	84,608

Clyde fine sandy loam.—The soil, from 9 to 12 inches, is a very fine sand to fine sandy loam of a brownish-gray or brown color, homogeneous in texture, friable, and easily kept in good tilth. The subsoil is a brown or yellow fine sand or fine sandy loam to a depth of 2 feet or more below the surface, overlying a clay similar to the subsoil of the Clyde loam. Both soil and subsoil are entirely devoid of gravel. Portions of the type seem to be the result of delta formations, subsequently modified by wind and wave action, while other portions occur in the form of low ridges as wind-blown beach deposits. The surface is slightly undulating to rolling, and drainage varies largely with local topography. Besides general farming and dairying, sugar beets, beans, and potatoes are important interests, and to a less extent chicory, apples, pears, grapes, and vegetables.

	1	2	3	4	5	6	7
Soil (3)	0	1	3	30	40	16	10
Subsoil (3)	0	2	4	35	36	12	11

	Acres.		Acres.
Cando, N. Dak	10,880	Oxford, Mich	1,6[illegible]0
Grand Forks, N. Dak	[a] 68,800	Saginaw, Mich	39,104

Clyde loam.—The soil ranges from a moderately friable loam to a rather heavy, compact loam of a dark-gray, brown, or black color, from 8 to 12 inches deep, resting upon a drab-colored sandy or silty clay somewhat streaked and mottled with iron stains. On account of former inadequate drainage much of the soil is still in a puddled and

[a] Mapped as Miami sandy loam.

compact state, sticky and impervious when wet, and very hard when dry. This condition is emphasized in low-lying areas that have been cultivated only a short time. In its natural state the soil possesses marked clayey properties to within a few inches of the surface, where there is an accumulation of organic matter. In the better drained areas the soil is mellow, and the subsoil, too, is more friable and pervious to water. The type is derived from glacial lake deposits that have not been modified to any extent by subsequent stream action. Its almost level surface with occasional low knolls and swells and intervening shallow depressions naturally causes poor drainage. When properly drained and cultivated, large crop yields are secured. The principal crops grown are corn, oats, wheat, hay, and sugar beets. It is considered an excellent soil for the latter crop.

	1	2	3	4	5	6	7
Soil (14)	1	4	6	18	14	33	22
Subsoil (15)	1	4	5	15	10	32	32

	Acres.		Acres.
Allegan County, Mich	[a]12,460	Island County, Wash	1,216
Alma, Mich	59,776	Newton County, Ind	960
Cando, N. Dak	70,016	Owosso, Mich	71,744
Carrington, N. Dak	24,768	Saginaw, Mich	242,496

Clyde silt loam.—The soil is a light to chocolate-brown silt loam 10 inches deep, resting upon a similar silt loam of a lemon-yellow color, containing little or no organic matter. The texture is very homogeneous to a depth of 3 feet, and gravel is entirely absent, but there are some bowlders strewn over the surface. The soil is very friable and easily kept in good tilth. The type seems to be derived from material carried by streams and deposited in the glacial lake. It is somewhat rolling in topography, and the drainage is fairly good. The soil is well adapted to grain and hay, and is used for general farm crops and for the production of chicory.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	3	12	65	18

	Acres.
Saginaw, Mich	3,904

Clyde clay.—The soil, from 6 to 9 inches deep, is a silty clay loam of a brown or black color. Where the proportion of organic matter is highest, the soil is darkest and more loamy and friable. The subsoil is a bluish or drab-colored clay, very tenacious and practically imper-

[a] Mapped as Allegan black clay.

vious to water. The type is derived from glacial lake deposits, and occupies low, wet, level areas, some of which were originally covered with peat. With good drainage the soil is well adapted to sugar beets, as well as to general farm crops.

	1	2	3	4	5	6	7
Soil (7)	0	3	3	10	8	39	36
Subsoil (8)	0	2	2	6	8	36	46

	Acres.
Cando, N. Dak	18,880
Saginaw, Mich	26,560
Toledo, Ohio	[a]165,056

SIOUX SERIES.

The Sioux series comprises the dark-brown to black terrace soils characterized and distinguished from the Wabash series by a bed of gravel usually within 3 feet of the surface. This gravel bed has a very marked effect upon the drainage of the soils, and causes crops to suffer in times of drought, except in areas where the gravel is several feet below the surface. This series occurs as terraces along streams and is practically confined to the glacial regions.

Sioux sand.—The soil consists of from 5 to 20 inches of loose, medium to coarse textured, dark-colored sand. The subsoil, which extends to great depths, has about the same texture as the soil, but is of a light-yellowish color. The type forms flat valley lands lying only 5 or 10 feet above mean water level. It is naturally well drained and seldom subject to overflow. In narrow valleys where moisture conditions are favorable the type is cleared and cultivated. Broad areas often suffer from drought, and are left to the native growth of scrubby pine and oak. The soil is sedimentary, but the material is derived more or less locally from underlying sandstone. It is used for corn, of which 40 to 80 bushels per acre are obtained under good moisture conditions and heavy fertilization. Vegetables, strawberries, and cranberries also do well on limited areas, but the greater part of the type can only be safely used for agriculture with some system of irrigation.

	1	2	3	4	5	6	7
Soil (2)	0	10	28	49	3	5	4
Subsoil (2)	0	10	32	50	3	3	3

	Acres.
Viroqua, Wis	19,520

[a] Mapped as Miami black clay loam.

Sioux sandy loam.—The soil is a coarse to medium brown sandy loam or heavy sandy loam from 10 to 24 inches deep, containing considerable organic matter. The color becomes lighter with depth. The subsoil over wide areas consists of almost pure waterworn gravel, which is found at an average of 22 inches below the surface and extends to great depths. The subsoil, however, varies considerably, and the gravel is frequently bedded in a matrix of sandy loam, silty sand, or sand. This is an alluvial soil occupying river terraces or bottoms, with level to gently rolling topography. The drainage is too thorough where the pure gravel subsoil predominates for good crop yields, although the soil is early and might be profitably utilized in the production of early, short-season crops. Hay, corn, oats, and alfalfa are important crops, but the yields are very irregular. In a wet season, or on areas of better moisture conditions, 40 to 60 bushels of corn are obtained per acre, but a dry spell at the critical period of growth often results in total failure. Some truck is grown. Clover and timothy have been produced with fair success.

	1	2	3	4	5	6	7
Soil (15)	2	14	15	18	8	27	16
Subsoil (15)	4	18	19	23	6	17	13

	Acres.		Acres.
Brookings, S. Dak	28,864	O'Fallon, Mo	320
Cerro Gordo County, Iowa	32,768	Tippecanoe County, Ind	9,216
Grand Island, Nebr	29,184	Viroqua, Wis	5,568
Janesville, Wis	[a] 51,968	Winnebago County, Ill	38,528

Sioux fine sandy loam.—The soil is a dark-gray or black fine sandy loam from 10 to 15 inches deep, containing a relatively high percentage of organic matter, resting on a subsoil of fine to medium sandy loam of a light-brown color. At from 3 to 8 feet below the surface the material changes to sand and gravel. The surface is generally level. The soil is alluvial and occupies both river bottoms and terraces. It generally maintains a good supply of moisture, although in areas of light rainfall irrigation is desirable. The drainage is, on the whole, satisfactory, artificial drains being necessary only in depressed areas. This is a desirable soil, yielding 15 to 35 bushels of wheat, 25 to 50 bushels of corn, 15 to 60 bushels of oats, about 40 bushels of barley, and 20 bushels of flax per acre. Alfalfa produces well and sugar beets give yields ranging from 8

[a] Mapped as Miami loam.

to 18 tons per acre. On low-lying areas considerable hay is made from wild grasses.

	1	2	3	4	5	6	7
Soil (5)	1	5	7	24	19	32	11
Subsoil (5)	2	7	7	26	18	28	12

	Acres.
Grand Island, Nebr	60,352
Jamestown, N. Dak	5,632

Sioux loam.—The soil consists of a brown, slightly sandy loam about 10 inches in depth. The surface is friable, easily worked, free from stones, and generally quite level. The subsoil has a depth varying between 20 and 40 inches, and consists of a brownish-yellow loam underlain by a reddish-gravelly loam, overlying a bed of gravel. The type constitutes the higher terraces formed by rivers during the close of the glacial epoch. It is admirably adapted to the production of crops for canning purposes, but is largely used for general farming.

	1	2	3	4	5	6	7
Soil (2)	3	16	10	9	6	35	21
Subsoil (2)	3	18	12	10	4	31	22

	Acres.
Tazewell County, Ill	[a]32,512
Tippecanoe County, Ind	896

Sioux silt loam.—The soil is a dark-brown, smooth, friable silt loam 12 inches deep, underlain by a reddish-yellow, heavier silt loam which in turn is underlain by sand or gravel at from 5 to 8 feet. The type occurs as terraces along streams. The surface soil is gently rolling, but the underlying gravel bed affords good underdrainage. This is an exceedingly fertile soil, very highly esteemed for corn and small grain.

	1	2	3	4	5	6	7
Soil (5)	0	1	1	1	6	70	20
Subsoil (5)	0	1	1	2	8	74	14

	Acres.
Janesville, Wis	[b]6,656
Tazewell County, Ill	[c]25,600
Tippecanoe County, Ind	570

Sioux clay. The soil is a black, dark-brown, or sometimes yellowish-brown clay loam or clay about 18 inches deep, underlain by a grayish-brown or grayish-yellow clay of stiff, tenacious, waxy texture. The

[a] Mapped as Miami loam.
[b] Mapped as Janesville loam.
[c] Mapped as Delavan silt loam.

type occupies river bottoms, and is partly alluvial and partly a wash from the uplands, the latter areas having the characteristics of the gumbo found in the Red River Valley. It is an excellent soil for small grain, wheat sometimes yielding as much as 40 bushels per acre. Oats and flax also do remarkably well. The lighter areas are suitable for certain of the truck crops. The native vegetation consists of oak, elm, ash, and other forest trees.

	1	2	3	4	5	6	7
Soil (2)	0	0	1	5	8	45	41
Subsoil (1)	0	1	2	9	5	31	52

	Acres.
Jamestown, N. Dak	2,432

SUPERIOR SERIES.

Another member of the Glacial Lake group of soils is found around Lake Superior. The material here consists of a red clay, over which in some places sands and sandy loams have later been deposited or washed from higher lying areas, giving rise to soils of a light and more sandy character. There has thus been formed the Superior series of soils, characterized by the red color of the subsoils.

Superior sandy loam.—A gray to reddish sand or light sandy loam, of medium texture, varying in depth from 12 to 24 inches. Sometimes the surface is strewn with small rocks and bowlders in such quantities as to interfere with cultivation. The subsoil is a stiff, tenacious, impervious red clay similar to the material forming the Superior clay, and it is sometimes interstratified with thin layers of fine sand. The sandy soil is the result of wash from higher lying sandy land. The type usually occupies level and gently rolling areas, with sufficient elevation to secure good natural drainage. It is a warm soil, easily tilled, and adapted to a variety of crops. The crops grown are clover, timothy, potatoes, and small fruits. The original timber growth is pine.

	1	2	3	4	5	6	7
Soil (3)	3	13	13	35	17	13	6
Subsoil (3)	1	5	5	15	12	30	31

	Acres.
Superior, Wis	14,208

Superior silt loam.—The soil to a depth of from 6 to 10 inches is a light very fine sandy or silty loam, underlain by a very fine sandy loam or silty loam, grading into a stiff, red clay at varying depths. The surface is usually rough and broken, being often deeply eroded by stream action. It is a lacustrine deposit consisting of reworked glacial material. On account of its uneven topography the type is not of much value for agricultural purposes.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	2	11	68	17
Subsoil (2)	1	1	1	1	7	66	23

	Acres.
Carlton area, Minn	16,192

Superior clay.—A heavy, compact, and almost impervious red clay, with no apparent difference in color or texture between soil and subsoil. When wet it is of a bright brick-red color, and quite adhesive and gummy; when dry cracks an inch or more in width are common on the surface, and the soil breaks up into cubical blocks. Sometimes there are small fragments of rock in both soil and subsoil, and usually upon new ground there is an inch or so of vegetable mould. The type occurs generally in broad and flat areas, with surface inclinations toward streams, and is very retentive of moisture. The soil is lacustrine in origin. It is adapted to timothy and clover. It improves with use, and good crops of potatoes, peas, beets and other root crops have been grown.

	1	2	3	4	5	6	7
Soil (7)	0	2	2	7	6	34	48
Subsoil (7)	0	1	2	5	5	35	50

	Acres.
Carlton, Minn	75,200
Munising, Mich	704
Superior, Wis	122,880

VERGENNES SERIES.

The Vergennes series occurs on the terraces surrounding Lake Champlain. It consists of deep-water sediments known as the Champlain clays, deposited in postglacial times over glacial drift during a period of submergence. Since the uplift these clays have been more or less modified by stream action and colluvial wash from soils of the surrounding highlands derived from the underlying geological formations, usually sandstone shale and limestone, and in limited areas by wash from glacial drift soils. The series is characterized by brown, yellowish, or gray soils, underlain by drab to blue or light-gray clay subsoils at varying depths. The surface is level to gently rolling, and for the most part artificial drainage is necessary.

Vergennes stony loam.—The soil consists of a clay loam or sometimes of a loam with an average depth of 8 inches. The subsoil is a gray clay similar to that of the material of Vergennes clay, but its depth is variable, depending on the position of the underlying rock. The type usually occupies long, narrow ridges or low hills, and also the lower slopes of higher hills. Outcrops of limestone occur and large quantities of limestone fragments are found scattered over local areas. The type has been derived from the Champlain clays. Most of the type is left in pasture or woodland. On the more level areas medium yields of corn and hay are secured. The soil is best suited to certain fruits, especially apples, an excellent quality of which is produced.

	1	2	3	4	5	6	7
Soil (2)	2	6	8	16	12	31	24
Subsoil (2)	2	5	7	17	11	29	29

	Acres.
Vergennes, Vt.-N. Y	17,024

Vergennes gravelly loam.—The soil is a sandy loam from 6 to 10 inches deep, containing from 10 to 45 per cent of fine gravel, pebbles, and small stones. The subsoil consists of light sandy loam or sticky sandy loam with a gravel content similar to that of the soil. In its lower depths the subsoil often grades into sand, with a high content of fine gravel. The type occupies two topographic positions; low bars and ridges surrounded by the Champlain clays of the region, where it represents delta deposits; and broken terrace formations along the ancient shore line. On account of its texture and position this soil is well drained and is susceptible to drought. On the more loamy areas fair yields of corn and hay are secured. The soil is well adapted to the production of potatoes.

	1	2	3	4	5	6	7
Soil (2)	7	17	14	19	11	20	11
Subsoil (2)	5	15	23	26	7	14	10

	Acres.
Vergennes, Vt.-N. Y	3,968

Vergennes fine sand.—The soil consists of a dark-brown, black or yellow loamy fine sand from 6 to 10 inches deep. The subsoil is a light-brown or yellow medium sand resting upon the basal clays of the region at depths ranging from 3 to 4 feet, though in rare instances the sandy material may be 6 feet or more in depth. Small quantities of gravel are frequently found in both soil and subsoil. This type of soil is quite varied in surface features, occurring in level areas, along slopes, and among foothills, and for the most part is well drained. It is a lacustrine deposit more or less modified by recent stream action. The soil is probably best adapted to truck crops and small fruits, though corn, oats, and hay are grown with fair success.

	1	2	3	4	5	6	7
Soil (3)	1	3	7	32	29	20	7
Subsoil (4)	1	3	6	37	29	17	5

	Acres.
Vergennes, Vt.–N. Y.	8,384

Vergennes sandy loam.—The soil is a black or dark-brown medium to fine sandy loam from 8 to 12 inches deep. The soil does not differ materially in texture from that of the Vergennes fine sand, but the subsoil is a drab clay loam or clay. In a few places the typical soil is underlain at an average depth of 12 inches by a layer of medium sand which rests directly upon the heavy underlying clay. In surface features the type is either level or rolling, marked sometimes by hummocks and low swells, and for the most part is well drained. In low-lying areas the soil is derived from late sedimentary deposits overlying the Champlain clays; other areas are either colluvial material or shore deposits overlying the Champlain clays. The type is adapted to corn, clover, and ate truck.

	1	2	3	4	5	6	7
Soil (1)	1	3	3	12	45	24	12
Subsoil (1)	0	1	1	13	36	29	20

	Acres.
Vergennes, Vt.–N. Y.	2,112

Vergennes loam.—The soil is a heavy fine sandy loam with an average depth of 10 inches. The subsoil is either a plastic mixture of clay and sand or a medium to heavy loam which often grades at 3 feet into a stiff clay similar to the subsoil of the Vergennes clay. The subsoil occasionally contains a small percentage of gravel and stones. The type occupies level areas or low, rounded or flat-topped hills and gentle slopes, and is derived from postglacial deposits, modified in some instances by colluvial material or stream action. The soil is desirable for corn, and also produces good crops of hay, oats, and barley.

	1	2	3	4	5	6	7
Soil (2)	2	4	4	19	26	25	19
Subsoil (2)	2	5	6	18	24	23	22

	Acres.
Vergennes, Vt.-N. Y	4,352

Vergennes black clay.—The soil consists of a black loamy clay from 6 to 15 inches deep. It contains a high percentage of organic matter and is very tenacious and sticky when wet, but is granular and friable when dry. The subsoil is a heavy, tenacious drab clay, somewhat plastic in certain areas. The soil is more often underlain at 24 inches by a stiff heavy clay similar to the subsoil of the Vergennes clay. The surface is usually flat or basinlike, and artificial drainage is often necessary to secure the best yields. The type owes its origin chiefly to wash from higher lands mingled with decaying vegetation, thus giving rise to a rich black soil. It is naturally a strong and productive soil and gives large yields of corn and hay.

	1	2	3	4	5	6	7
Soil (2)	1	3	2	3	2	33	55
Subsoil (3)	1	1	1	4	6	36	51

	Acres.
Vergennes, Vt.-N. Y	3,584

Vergennes clay.—The surface soil consists of heavy gray clay or light-brown clay loam varying in depth from 6 to 12 inches. The subsoil is a gray, drab, or light-brown heavy clay, somewhat tenacious when wet, but extremely stiff, compact, and intractable when dry. Wherever the soil is so shallow that the plow goes below it, the upturned furrows of the underlying gray clay become white upon exposure to the atmosphere, and this has given rise to the local term "white-faced clay." On the steep slopes of many ridges outcrops of slate are frequent, and thin fragments are often strewn over the tops and the steeper slopes. The type for the most part is level or gently rolling, broken only by occasional ridges. Except in the depressions it has sufficient surface drainage. As the greater part of this soil is compact and impervious to moisture, underdrainage would result in better crop returns. This soil is derived from the postglacial or Champlain clays. The glacial material comes to the surface, or nearest it, on the hills, and in some cases this has been washed down the slopes and mingled with the postglacial clays. This is an excellent soil for hay. Other crops grown with profitable yields are corn, oats, and barley.

	1	2	3	4	5	6	7
Soil (3)	2	3	2	3	3	18	69
Subsoil (3)	0	1	2	2	2	22	71

	Acres.
Vergennes, Vt.-N. Y.	129,984

MISCELLANEOUS SOILS OF THE GLACIAL AND LOESSIAL REGIONS.

Portage stony sandy loam.—The soil is a rather loose dark-gray or brown sandy loam of medium to fine texture and from 8 to 10 inches deep. The underlying material is a yellowish-brown or gray sand of fine to medium texture to a depth of 30 inches, where a yellow or gray sandy clay sometimes occurs. On the surface considerable quantities of bowlders, principally of granite, are found, and outcrops of the underlying crystalline rocks from which the type is in part derived frequently occur. The origin of the type has been influenced to some extent by glacial action. The drainage is rather poor, and the type is used only for pasturage.

	1	2	3	4	5	6	7
Soil (2)	2	12	21	36	9	12	8
Subsoil (2)	2	9	21	42	10	8	8

	Acres.
Portage County, Wis.	11,392

Barnum stony loam.—The soil to a depth of 12 inches is a light-brown loam, underlain by a loam grading into red clay at from 22 to 36 inches. On the surface and mixed with the soil are stones and bowlders in considerable quantity. The surface is rolling and hilly, and the natural drainage is generally good. It is a glacial soil, and where not too rough and the stones not too numerous is adapted to oats, hay, and wheat.

	1	2	3	4	5	6	7
Soil (2)	1	3	6	16	11	45	18
Subsoil (2)	1	2	6	17	12	39	23

	Acres.
Carlton area, Minn.	8,704

Gloucester stony loam.—The soil is a light-brown sandy loam underlain at about 10 inches by a more sandy and gravelly material of gray color. The subsoil is a mass of rock fragments, or the thin soil may rest directly upon bed rock. From 20 to 80 per cent of bowlders occur on the surface and throughout the soil profile, while frequently the bed rock is exposed. The type usually presents a rough, broken topography, hilly and almost mountainous in character, and on account of its position and the loose, open character of the subsoil it is thoroughly drained. The soil is in part residual and in part glacial in origin, bearing, however, a distinct relation to the underlying or adjacent rock from which, in the main, it has been derived mechanically. Very little of it is cleared and under cultivation, and it is covered for the most part with a stunted growth of chestnut, oak, white birch, and undergrowth. Some corn and potatoes are produced; but only light yields are obtained. The type as a whole is best suited to forestry and pasturage, though in some places orcharding should be profitable.

	1	2	3	4	5	6	7
Soil (3)	5	9	6	22	19	33	6
Subsoil (3)	8	13	7	23	19	28	2

	Acres.
Rhode Island	325,120

Holyoke stony loam.—This soil is of glacial origin, and consists of about 3 feet of loam, containing 10 to 50 per cent of diabase and other bowlders. The areas occupied are rough and mountainous, occurring along the base of diabase ranges. The soil is chiefly devoted to pasture, though it is used also to some extent for fruit.

	1	2	3	4	5	6	7
Soil (2)	2	6	5	15	24	42	6
Subsoil (2)	5	9	7	21	23	30	6

	Acres.
Connecticut Valley, Conn.-Mass	196,818

Cassadaga sand.—This is a coarse orange or gray sand, 1 to 3 feet or more in depth. The type occurs usually in upland valleys, is commonly wooded, and generally has a thick growth of underbrush. The soil is inclined to be wet or marshy, and needs drainage because of a hardpan subsoil. Very little of this type is under cultivation, and it has at present little agricultural value. If it were cleared and drained it would probably be suited to grass.

	1	2	3	4	5	6	7
Soil (1)	2	8	13	33	11	22	10

	Acres.
Westfield, N. Y	1,660

Saugatuck sand.—The soil to a depth of 9 inches consists of reddish-brown, black, and gray sand. The subsoil to a depth of 3 feet or more consists of medium fine sand, containing bands of sand cemented by ferruginous material. These bands of iron crusts vary from a fraction of an inch to 1 or more feet in thickness. The type occupies slightly depressed areas. The soil is best adapted to truck, peaches, and small fruits, and grain does fairly well.

	1	2	3	4	5	6	7
Soil (2)	1	6	34	44	4	7	3
Subsoil (2)	1	10	37	43	3	3	3

	Acres.
Allegan County, Mich	24,120

Shelby sand.—The soil is a brown or yellow loamy sand, 10 inches deep, grading into reddish-yellow sand of medium texture, underlain at from 24 to 36 inches by sandstone in place. The subsoil is derived from underlying rock, the soil being a covering of wash material. The type occurs as gently rolling upland, just above the second bottoms. The soil is adapted to truck, small fruit, peaches, and wrapper leaf tobacco.

	1	2	3	4	5	6	7
Soil (1)	1	7	10	30	14	28	9
Subsoil (1)	2	9	16	43	9	11	10

	Acres.
Shelby County, Mo	448

Snohomish sand.—This soil consists of a brown medium sand about 15 inches deep overlying a loose gray to greenish-yellow sand. The surface is flat and fairly level, rising with a gentle incline from near sea level toward the inland. While the drainage is generally adequate on account of the easy fall and open texture, the soil is subject to drought. The type has been laid down as glacial deposits under uniform conditions. The soil is too light for general farming. It is, however, quite similar to some of the eastern truck soils and would under suitable conditions be a typical early truck soil. It is adapted to early potatoes.

	1	2	3	4	5	6	7
Soil (2)	3	19	17	35	11	8	7
Subsoil (2)	2	17	18	40	13	6	4

	Acres.
Everett, Wash	21,501

Wheatland sand.—This is a dark-brown sand, 12 to 18 inches deep, underlain by grayish-yellow sand of the same texture. It is an upland soil of glacial origin. The soil has little agricultural value, and is best adapted to pasture and grazing.

	1	2	3	4	5	6	7
Soil (2)	1	3	5	49	22	12	7
Subsoil (2)	15	10	5	26	14	13	11

	Acres.
Fargo, N. Dak	29,504

Newton fine sand.—The soil consists of a light-gray to yellowish fine sand which is underlain at depths varying from 10 to 36 inches by interstratified layers of peat and black fine sand. The surface is generally level, although somewhat broken by ponds and swampy depressions. The type has probably been formed by the deposition of a layer of light-colored fine sand over the black fine sand, which gives rise to the Clyde fine sand. Much of the type supports a growth of water-loving grasses, willow, and birch, and its chief use is for pasture.

	1	2	3	4	5	6	7
Soil (3)	0	1	4	88	5	1	1
Subsoil (1)	0	1	3	79	10	5	2

	Acres.
Newton County, Ind	5,888

Manchester sandy loam.—The soil is a reddish or dark-yellow medium sandy or gravelly loam from 8 to 18 inches in depth, underlain by loamy sand and gravel, frequently containing large bowlders. The surface is generally rolling, in the form of ridges and knolls, though the type occasionally occurs as low, flat terraces. The type is a combination of glacial lake and stream deposits, and the material is exceedingly irregular in thickness. It is formed in part of the red Triassic rocks. The soil is naturally fertile, but the porous subsoil renders it readily subject to drought. It is well adapted to peaches and fairly well adapted to corn.

	1	2	3	4	5	6	7
Soil (2)	5	14	14	35	15	11	5
Subsoil (2)	7	18	15	29	17	9	4

	Acres.
Connecticut Valley, Conn.-Mass	44,160

Portage sandy loam.—The soil to a depth of from 8 to 9 inches is a grayish-brown sandy loam of fine to medium texture. Below this occurs a brownish-yellow sandy loam grading in the lower part of the profile into a mottled gray and yellow sandy clay. The topography varies from gently rolling to nearly level, the latter areas being rather poorly drained. The type is derived from crystalline rocks, though it is modified to some degree by glacial drift. It is adapted to general farm crops, yielding 1½ tons of hay, 100 bushels of potatoes, 30 bushels of corn, 40 bushels of oats, and 10 to 15 bushels of rye per acre. Small fruits and vegetables also do well.

	1	2	3	4	5	6	7
Soil (3)	2	17	21	23	7	18	11
Subsoil (3)	2	13	18	22	7	19	18

	Acres.
Portage County, Wis	9,792

Saginaw sandy loam.—The soil to an average depth of 12 inches is dark-gray to black medium to fine-textured sandy loam, carrying a high percentage of organic matter, which has accumulated as a result of poor drainage conditions. It is loose, mellow, and easily kept in good tilth. The subsoil is dark gray in color and about the same in texture as the soil to a depth of 24 to 30 inches, where it is underlain by a heavy blue silty clay. The type occupies an intermediate position between the Clyde sand and the Clyde loam. Its origin, topographic, and drainage features are essentially the same as the former, namely, reworked glacial material, level topography, and naturally deficient drainage. When properly drained the soil is fairly well adapted to truck, sugar beets, and corn, as well as to general crops.

	1	2	3	4	5	6	7
Soil (4)	2	10	20	41	7	14	7
Subsoil (4)	2	9	22	37	9	14	8

	Acres.
Owosso, Mich	1,280
Saginaw, Mich	12,992

Wheatland sandy loam.—The soil consists of a dark-brown sandy loam about 14 inches deep, underlain by loam which at a depth of 6 feet or more rests upon a grayish-yellow or yellow glacial till. Glacial bowlders and rock fragments occur throughout the soil and subsoil. This is an upland soil and is generally well drained. It is fairly well adapted to wheat, oats, barley, flax, and corn.

	1	2	3	4	5	6	7
Soil (3)	2	4	5	18	20	32	19
Subsoil (3)	2	5	5	18	19	25	25

	Acres.
Fargo, N. Dak	16,768

Snohomish fine sandy loam.—The soil to a depth of 15 inches consists of a brown fine sandy loam. The subsoil is a brown to yellow heavy fine sandy or silty loam. Small gravel and a few cobblestones occur throughout both soil and subsoil. The type occupies level to gently rolling river terraces and is formed from reworked glacial material. The type is best adapted to late truck crops for canning purposes. Fruit does well.

	1	2	3	4	5	6	7
Soil (2)	2	6	5	19	22	33	13
Subsoil (2)	1	4	4	13	17	44	16

	Acres.
Everett, Wash	9,728

Barnum loam.—The soil to a depth of 8 to 14 inches is a brown loam carrying a small amount of gravel. The subsoil is a heavy loam, usually lighter in color than the soil, and grades into a stiff brownish-red clay at from 18 to 24 inches. On the surface are stones and bowlders, though not in sufficient quantity to interfere with cultivation. The surface is rolling, and natural drainage is generally good. It is a glacial soil and is adapted to hay, oats, and wheat.

	1	2	3	4	5	6	7
Soil (1)	1	3	7	18	10	43	17
Subsoil (1)	1	2	3	11	10	45	28

	Acres.
Carlton, Minn	2,496

Bernardston loam.—The soil is a light clayey or silty loam of dark color, 10 inches in depth, underlain by about 14 inches of dark-yellowish loam grading into a dark slaty blue clay loam of very compact nature. It occurs in very broken and hilly areas, and outcrops of the underlying argillaceous rocks are very common. Cultivated areas of the soil occur very largely in drumlinoid hills. The native vegetation is made up largely of hardwoods, particularly sugar maple, but in the most stony areas, where the soil is shallow, chestnut, pine, and hemlock are common. It is a glacial soil, made up of argillaceous rock material. It is very productive, being particularly fine for grass and grazing land. It also produces excellent crops of corn, oats, and rye.

	1	2	3	4	5	6	7
Soil (2)	6	8	4	14	20	34	14
Subsoil (2)	5	7	4	14	19	36	15

	Acres.
Connecticut Valley, Conn.-Mass.	16,064

Elmwood loam.—This soil is a dark-brown fine sandy loam, 2 feet in depth, overlying a close, poorly drained clay. It occupies level terraces along the Connecticut River and is a lacustrine deposit. The type has very little present agricultural value on account of its compact nature and poor underdrainage.

	Acres.
Allegan County, Mich	3,810
Connecticut Valley, Conn.-Mass.	18,878

Madison loam.—The soil is a loose, friable brown or yellow loam or fine sandy loam from 8 to 14 inches deep, resting upon a heavy loam or clay, usually becoming heavier below 24 inches. Throughout the soil and subsoil there are a few well-rounded gravel. The subsoil is somewhat variable, occasionally consisting of alternating layers of sand and clay, with an occasional layer of cherty gravel. The type occurs as second bottoms and is generally level. This is an alluvial soil, derived from wash of valley slopes. Frequently the drainage is poor. It is a good soil for corn and hay and for truck crops, especially for cabbage, tomatoes, and berries.

	1	2	3	4	5	6	7
Soil (2)	1	4	3	14	12	39	27
Subsoil (2)	1	3	3	15	14	39	25

	Acres.
Madison County, Ind	2,240

Shelby loam.—This type consists of a fine sandy or silty loam of a gray or brown color from 3 to 8 inches deep, grading into a reddish-yellow sandy clay which extends to a depth of 3 feet or more. It is locally termed "white-oak lands." Iron pipes and concretions are usually found. The subsoil is made up mainly of pockets of sand and clay, with occasional thin lenses of cherty gravel. The type is of glacial origin. It occurs below the Shelby silt loam and is exposed through stream cutting and erosion of the overlying prairie. It occupies steep slopes adjacent to the water courses. Native growth is white and scrub oak with a scattering of red oak and hickory. It is much less productive than the Shelby silt loam. It is poorly adapted to wheat and corn. The former yields an average of about 10 bushels and the latter about 25 bushels per acre. The soil is used almost exclusively for pasture.

	1	2	3	4	5	6	7
Soil (3)	2	5	7	19	13	40	13
Subsoil (3)	2	5	5	13	10	25	40

	Acres.
Scotland County, Mo	94,016
Shelby County, Mo	[a] 71,168

Warners loam.—The soil consists of 10 inches of mellow brown loam, containing many calcareous nodules and a considerable proportion of marl, resting on a subsoil of white or gray marl. The soil is silty in character and of soft, unctuous feel, containing thin layers of muck at various depths. It produces fairly good crops of corn and grass.

	Acres.
Syracuse, N. Y	128

Lexington silt loam.—The soil to a depth of about 12 inches is a gray or yellowish-gray mellow silt loam. The subsoil to a depth of 36 inches is either a compact silt loam slightly heavier than the soil or a silty clay varying from yellow to brown in color or sometimes tinged with red. The surface is moderately rolling to hilly, the rougher portion being largely the result of erosion. The drainage is good and crops suffer during extended droughts. The type is derived from loess and closely resembles the Memphis silt loam; but the deposit of loess is very thin, and the soil is in places modified by the underlying Orange sand formation. The soil is adapted to corn, cotton, forage crops, vegetables, and strawberries. The natural forest growth consists of white, red, post, and black-jack oak, chestnut, hickory, and black gum.

	1	2	3	4	5	6	7
Soil (2)	0	2	2	6	5	69	15
Subsoil (2)	0	1	2	4	2	63	28

	Acres.
Henderson County, Tenn	241,344

Marion silt loam.—The soil consists of silt loam of light-brown to white color, with an average depth of 12 inches. The subsoil consists of a hard, stiff silty clay of mottled appearance, locally known as "hard-pan," the predominating colors being gray, light yellow, and reddish yellow. Between the soil and subsoil occurs a white layer of compact silt, which crumbles easily between the fingers. The type occupies the

[a] Mapped as Shelby clay.

level prairie land and is of loessial origin. Wheat, corn, and grass are the principal crops. The yield of grain is rather small, but apples do well.

	1	2	3	4	5	6	7
Soil (13)	0	1	1	2	5	75	15
Subsoil (13)	0	1	1	2	4	60	31

	Acres.		Acres.
Clay County, Ill	260,511	O'Fallon, Mo	175,552
Clinton County, Ill	172,480	St. Clair County, Ill	86,464

Memphis silt loam.[a]—This soil is a yellow or brown silt loam 8 inches in depth, powdery when dry. Under this is a chocolate-brown or yellow compact silt loam, which in turn is underlain at a depth of from 2 to 6 feet by a yellow silt of loess formation. The type occupies uplands and is subject to serious erosion. It is largely forested to oak, hickory, and beech. In Mississippi it is divided topographically into two regions—the Cane Hills, which are steep-sided and narrow-topped, and the Flat Hills, which are more plateaulike and cultivated to a greater extent than the Cane Hills. Good yields of cotton, corn, wheat, oats, hay, and potatoes are secured in different localities. In northern areas the soil is good for fruits and vegetables.

	1	2	3	4	5	6	7
Soil (18)	0	1	1	1	4	78	15
Subsoil (18)	0	1	1	2	3	73	20

	Acres.		Acres.
Crystalsprings, Miss	46,016	O'Fallon, Mo	5,376
East Baton Rouge Parish, La	219,200	St. Clair County, Ill	[b]138,560
Jackson, Miss	410,624	Smedes, Miss	52,288
Johnson County, Ill	167,104	Yazoo, Miss	140,690
McCracken County, Ky	139,776		

Portage silt loam.—The type consists of a grayish-colored silt loam 8 or 10 inches deep, underlain by a mottled gray and yellow heavy clay loam. At a depth of about 25 inches a thin stratum of sand, sandy loam, or sandy clay frequently occurs, grading quite abruptly into a dark-red clay. The type occupies level or slightly undulating areas, is rather poorly drained, and sometimes marshy. The type is derived from glacial material over crystalline rocks. It is well adapted to general farm crops, small fruits, and vegetables.

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[a] See also Lintonia loam, p. 91.

[b] Mapped as Miami fine sandy loam.

	1	2	3	4	5	6	7
Soil (3)	1	5	3	4	5	58	23
Subsoil (1)	1	17	20	28	5	12	16
Lower subsoil (1)	1	6	8	14	6	25	40

	Acres.
Portage County, Wis	22,656

Safford silt loam.—To a depth of 8 to 10 inches the soil consists of a gray or light-yellow silt loam. This is underlain by a tough, plastic clay or clay loam of a red or reddish-brown color, grading at a depth of about 3 feet into greensand. The surface soil is loose and rather incoherent when dry, and is easily cultivated. It has a rolling to hilly topography and washes badly if not properly managed. The natural drainage is good. The silt loam covering is due to a deposit of loess, while the subsoil is derived from the weathering of the greensand marl or a shallow deposit of clayey material above it, or from a mixture of both. The soil is adapted to corn, cotton, wheat, and hay. The timber growth consists of white, red, black-jack, and post oak, chestnut, and some hickory and beech.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	4	17	61	16
Subsoil (3)	0	0	1	3	12	30	54

	Acres.
Henderson County, Tenn	28,544

Scottsburg silt loam.—This soil is an ashy-gray silt loam, with variations tending to a fine sandy loam. At about 10 inches it grades into a light-yellow or slightly mottled silt loam, becoming gradually heavier and more compact as the depth increases, until at 30 to 36 inches is found a heavy silt loam of a drab or gray color, slightly mottled with yellow stains. Small iron concretions permeate the entire depth. The type is the result of local material, redeposited by glacial action, mixed with the weathered material of the underlying argillaceous and sandy shales. The areas were probably at one time level, but have been eroded by stream action until they present a gently rolling topography. The soil is best adapted to tomatoes and other vegetables, small fruits, and all early maturing crops. By adding humus and adopting crop rotations general crops may be made to do well.

	1	2	3	4	5	6	7
Soil (3)	1	3	3	7	9	65	12
Subsoil (3)	1	2	2	5	8	62	19

	Acres.
Scott County, Ind	37,184

Shelby silt loam.—The soil is a dark-gray to almost black silt loam from 6 to 10 inches deep, underlain by a stiff, impervious brown or drab mottled silty clay, streaked with blue and red. A thin layer of white silt is often found between soil and subsoil. This type resembles both the Marshall and Marion silt loams. It differs from the former in having a heavy, impervious subsoil and from the latter in the darker color of the surface soil. It is derived from a deposit of loess over glacial material. The type is known locally as "the prairie" and occupies level to gently rolling uplands. The greater part is fairly well drained, but the impervious subsoil allows water to collect on very level areas after heavy rains. The principal crops on this type are hay, corn, oats, and wheat, with millet, Kafir corn, and sorghum as secondary crops. Fruit also does well, and the production of apples is of some importance.

	1	2	3	4	5	6	7
Soil (3)	0	2	1	1	3	74	19
Subsoil (3)	1	3	1	1	2	55	38

	Acres.
Scotland County, Mo	136,704
Shelby County, Mo	216,896

Snohomish silt loam.—The soil to a depth of 12 inches is a reddish-brown light silty loam, and is underlain to a depth of 3 feet or more by a yellow or drab silt loam or silty clay. The topography of this type is level or gently rolling. It occupies chiefly lower river terraces, and the drainage is good. It owes its origin to the modification of glacial sediments by the action of streams. This is a good soil for general farming, and fruit trees do well on it.

	1	2	3	4	5	6	7
Soil (2)	1	4	2	6	9	60	18
Subsoil (2)	1	3	2	5	10	53	26

	Acres.
Everett, Wash	16,192

Fargo clay.—The soil is a heavy black clay 6 to 14 inches deep, underlain by gray or blue clay of the same texture. At from 5 to 9 feet occurs a mottled gray, brown, and yellow clay, similar to the subsoil of the Miami black clay loam. When wet this type is very waxy and gummy and has an oily feel. It is exceedingly slippery under foot and often sticks to wagon wheels in great quantities. The type occurs in depressions in the upland. The drainage is poor and the soil is difficult to till. It is a very strong and productive soil when well drained, and is adapted to general farm crops.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	3	9	36	50
Subsoil (2)	0	1	1	1	5	26	66

	Acres.
Fargo, N. Dak	40,000

Hobart clay.—This consists of a shallow covering of from 1 to 4 inches of a gray or dark-brown clay, underlain to a depth of 3 or 4 feet by heavy drab-colored clay. Below this the subsoil is mixed with fragments of the underlying shale, and finally grades into shale rock. The soil as well as the subsoil contains fragments of shale. When the soil is wet it is very adhesive under foot and has a greasy, oily feel. In dry weather it often bakes to the detriment of growing crops. On account of the impervious clay and shale underlying the soil there are many fresh-water springs. Owing to the stiff, tenacious character of the soil and its location on the steep sides of bluffs it has little value except as a sheep and cattle pasture.

	1	2	3	4	5	6	7
Soil (2)	3	7	4	13	4	31	38
Subsoil (4)	1	3	1	2	2	15	76

	Acres.
Carrington, N. Dak	2,496
Jamestown, N. Dak	3,712

RESIDUAL SOILS OF THE WESTERN PRAIRIE REGION.

This region consists of the nonglacial part of the prairie plains bounded on the north by the Missouri River, the southern limit of glaciers, and extending southward through Texas to the Rio Grande. On the west it merges into the Plateau region at very near the 2,000-foot contour, and on the east is limited by the Gulf Coastal Plain and the Ozark Plateau. Its surface is gently rolling, with occasional low hills, and is cut by numerous stream channels. The rocks are of Carboniferous age and consist of sandstones, shales, and limestones more or less interbedded. These rocks give rise to three series of soils, viz, Oswego, Crawford, and Vernon, together with a number of miscellaneous soils. In Kansas and Texas these soils are in some instances more or less modified by the admixture of gravel and sand from Tertiary deposits brought down from the higher areas farther west occupied by crystalline rocks.

OSWEGO SERIES.

The Oswego series includes the light-colored soils of the prairie region formed from the weathering of interbedded layers of sandstone and shale, as distinguished from the Crawford series, which is derived from limestones. The surface soils are light to dark gray in color, while the subsoils are dark drab to yellow. The soils of the Oswego series are less productive than those of the Crawford series.

Oswego fine sandy loam.—The soil is a yellowish-brown heavy fine sandy loam with a depth of 12 inches, resting on a subsoil of the same material but of a lighter yellowish color and somewhat heavier in texture. This is an upland soil occupying low, rounded knobs and ridges and having a rolling surface. The drainage is excellent. The type is residual, being derived from sandstone and arenaceous shale, which occurs in places a few feet beneath the surface. Corn and oats are the important crops, the former yielding from 20 to 30 bushels and the latter about 25 bushels per acre. Very little wheat is grown on this soil, as it is likely to winterkill. The soil is best adapted to fruit and truck.

	1	2	3	4	5	6	7
Soil (3)	0	1	0	18	33	34	13
Subsoil (3)	0	1	1	18	30	33	17

	Acres.
Allen County, Kans	15,565
Parsons, Kans	9,728

Oswego silt loam.[a]—The soil is a gray to yellowish silt loam 10 inches deep, grading into a stiff silty clay, becoming stiffer and more impervious as the depth increases. The type occupies gently rolling upland prairies, and is derived from shale, with here and there an interbedded layer of sandstone or limestone, and in places outcrops of bituminous coal. When dry the soil is apt to bake and crack, but breaks up into a mellow loam when plowed. This is a soil of fair productivity, and is used for general farm crops. The average yield of wheat is about 18 bushels, of corn 25 bushels, and of potatoes 80 to 100 bushels per acre. Flax and rye are grown to some extent.

[a] See also Neosho silt loam, p. 95.

	1	2	3	4	5	6	7
Soil (6)	0	1	1	3	13	66	15
Subsoil (6)	0	1	1	3	10	59	26

	Acres.
Allen County, Kans.	177,600
Parsons, Kans.	[a] 92,096

CRAWFORD SERIES.

This series includes residual limestone soils of the prairie regions, characterized by dark-brown to reddish-brown surface soils and reddish-brown to red subsoils. While derived from limestones these soils usually contain only a small percentage of lime, differing very materially in this respect from the soils of the Houston series, occurring in the Cretaceous black prairies of the Coastal Plain. They are productive and well adapted to general farming.

Crawford stony clay.—The soil consists of a dark reddish-brown clay or clay loam 10 inches deep. The subsoil is a stiff, reddish-brown compact clay. A large number of limestone fragments of various sizes are scattered over the surface and throughout the soil profile, while at a depth of from 12 to 20 inches the parent limestone is encountered. Many areas have comparatively few rock fragments on the surface, but the underlying limestone is encountered at shallow depths and even outcrops in small eroded areas. The type occurs along slopes of streams in rolling prairies and in rough, broken country. It supports an excellent growth of native grass, which makes it a valuable pasture land. A large proportion is too rough and stony for agricultural purposes, but where cultivation is practicable the soil is well adapted to cotton, corn, sorghum, and oats. Some areas are well suited for orchards and vineyards. It supports a growth of oak and cedar.

	1	2	3	4	5	6	7
Soil (3)	1	1	1	3	6	46	42
Subsoil (3)	1	1	1	3	7	47	41

	Acres.
Austin, Tex.	[b] 56,256
San Antonio, Tex.	[b] 16,768
Waco, Tex.	27,264

[a] Mapped as Oswego loam.
[b] Mapped as Colton stony clay.

Crawford gravelly loam.—The soil is a very dark to black compact gravelly loam, with a depth of about 8 inches, and contains from 10 to 50 per cent of rounded chert fragments of a reddish tinge. The subsoil is a very stiff, tenacious red clay in which small quantities of the same gravel usually occur. The gravel content varies greatly in both soil and subsoil. The soil is derived principally from limestone, and probably represents the remnant of a gravelly formation. The type occurs in knobs and ridges which rise from 5 to 30 feet above the general level, thus presenting a rolling topography and affording good surface drainage. The gravel in the soil permits ready subdrainage. The type as a whole is best adapted to pasture, but where not too gravelly corn is successfully grown, especially in wet seasons. Grapes, peaches, and some other fruits would probably do well on some parts of this soil.

	1	2	3	4	5	6	7
Soil (1)	2	1	1	1	5	62	28
Subsoil (1)	3	2	1	4	7	53	30

	Acres.
Allen County, Kans	[a] 5,165

Crawford loam.—This soil is a brown to reddish-brown loam 12 inches deep. The immediate surface soil carries considerable fine sand and has the general appearance of a fine sandy loam. The subsoil is a heavy brown loam, passing usually at about 25 inches into a stiff, compact clay more nearly red in color. It is characterized by rolling topography and is well drained but not seriously eroded. The soil is derived from the weathering of sandy, ferruginous clays, impure limestone, and sandstone. It is easily tilled, is well suited to cotton and corn, and produces fair yields of wheat and oats. Peaches, plums, small fruits, and vegetables also do well.

	1	2	3	4	5	6	7
Soil (2)	0	1	3	22	22	32	20
Subsoil (2)	0	1	2	17	16	38	25

	Acres.
Waco, Tex	6,784

Crawford silt loam.—The soil to an average depth of about 10 inches is a reddish-brown to dark-brown friable silt loam, having a decided tendency to dry out in periods of drought, making frequent cultivation necessary. The subsoil is a red or brown silt loam or clay loam.

[a] Mapped as Sedgwick gravelly loam.

generally somewhat open and granular, but becoming more compact and stiffer with increased depth. The type is derived from limestone, which is frequently encountered 2 to 5 feet below the surface. The type occupies level to rolling prairies and is well drained except in depressions and flat areas, where it is generally best suited to pastures. The soil is best adapted to corn, but all general farm crops, as well as fruit and vegetables, do fairly well.

	1	2	3	4	5	6	7
Soil (6)	0	1	1	3	9	68	18
Subsoil (6)	1	1	1	4	6	64	23

	Acres.
Allen County, Kans	[a] 75,239
Wichita, Kans	[a] 136,320

Crawford clay.—The soil is a brown or slightly reddish clay or clay loam 10 inches deep, stiff and tenacious when wet, but friable and granular when dry and well cultivated. The subsoil is a stiff, tenacious clay of a lighter reddish-brown color, becoming stiffer and more compact with increased depth. It is derived from the weathering of limestone, which is frequently found at a depth of 3 or 4 feet below the surface. The type occupies gently rolling to rolling upland plateaus and is naturally well drained. The soil is well adapted to wheat, while corn, cotton, alfalfa, clover, and timothy do well.

	1	2	3	4	5	6	7
Soil (5)	1	2	1	5	10	50	31
Subsoil (5)	1	2	1	5	8	43	39

	Acres.
Parsons, Kans	[b] 68,544
Waco, Tex	112,320

VERNON SERIES.

The Vernon series includes the upland sands, loams, and clays derived from the weathering of the Permian Red Beds. The surface soils are gray and brown, while the subsoils are brown to red. This series occurs in the prairie regions of northern Texas and in the Indian Territory and Oklahoma. The soils are productive and well adapted to general farm crops.

[a] Mapped as Sedgwick clay loam.
[b] Mapped as Yazoo clay.

Vernon sand.—The soil is a loose gray to reddish-brown medium sand about 18 inches deep, underlain by slightly more compact reddish-yellow sand to a depth of 3 feet or more. The surface is hummocky to dunelike, and the type is well drained. The soil has been formed largely by wind action. Kafir corn, sorghum, and cotton are the principal crops. Apples, peaches, and melons do well.

	1	2	3	4	5	6	7
Soil (2)	0	7	19	40	19	9	6
Subsoil (2)	0	5	15	38	19	16	9

	Acres.
Vernon, Tex	[a] 56,448

Vernon sandy loam.—The soil is a dark-red to reddish-brown sandy loam from 12 to 18 inches deep, and is mellow, friable, and easily worked. The subsoil to a depth of 36 inches is heavier in texture and varies in color from red to brown. The soil has been formed by the intermingling of wind-blown sand with the Vernon silt loam, and is generally well drained. Corn, wheat, Kafir corn, oats, and cotton are the principal crops grown on this soil type.

	1	2	3	4	5	6	7
Soil (1)	1	8	17	25	22	14	11
Subsoil (1)	1	7	15	23	19	16	18

	Acres.
Vernon, Tex	30,592

Vernon fine sandy loam.—The soil is a fine to very fine brownish-red sand about 22 inches deep, carrying much silt. The subsoil is the same as the soil, except that it is a little lighter in color in the lower depths. From 4 to 6 feet the material is generally a yellowish-red fine sand. The surface is slightly rolling and the drainage excellent. The type is derived from wind-blown river sand when the streams were at higher levels, and occupies bluffs along rivers. The soil is used principally for pasturage, but is adapted to wheat, corn, oats, cotton, and other farm crops.

	1	2	3	4	5	6	7
Soil (2)	0	1	2	3	36	54	7
Subsoil (2)	0	0	1	2	35	53	9

	Acres.
Vernon, Tex	5,248

[a] It is now recognized that the bottom-land phase of this soil should have been correlated with the Miller fine sandy loam.

Vernon silt loam.[a]—The surface soil is a reddish-brown to dark-brown silt loam 12 inches deep, and mellow, friable, and easily worked. The subsoil is a light reddish-brown silt loam, heavier in texture than the soil, and at from 3 to 6 feet is underlain by a friable red clay. The type occupies level and slightly rolling areas of the prairie upland, is fairly well drained, and is derived from the weathering of material forming the Permian Red Beds. Corn, wheat, oats, Kafir corn, and sorghum are the principal crops grown on the type.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	3	15	70	10
Subsoil (3)	0	1	2	6	13	63	14

	Acres.
Vernon, Tex.	[b]59,392

Vernon clay.—This is a red clay to heavy clay loam about 9 inches deep, in some localities containing a small percentage of rounded quartz gravel. The subsoil is a heavy, sticky red clay. It often contains waterworn gravel from 3 to 4 inches in diameter. The type is derived from the Permian Red Beds, and is the underlying basal clay of the Vernon loam. The soil is principally used for pasture.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	2	23	59	14
Subsoil (2)	0	0	1	2	17	62	18

	Acres.
Vernon, Tex.	22,592

MISCELLANEOUS RESIDUAL SOILS OF THE WESTERN PRAIRIE REGION.

Derby loam.—This type is a mellow yellowish-brown to reddish-brown silty loam, 10 inches deep, grading almost imperceptibly into a rather heavy, reddish-brown silty loam subsoil. It occupies rolling upland prairie and is well drained. This is a good soil for general agriculture. Corn and wheat are the chief crops, corn yielding about 25 bushels and wheat about 18 bushels per acre.

	1	2	3	4	5	6	7
Soil (2)	1	2	1	7	28	42	19
Subsoil (2)	0	2	3	9	21	45	20

	Acres.
Wichita, Kans.	20,416

[a] See also Miller silt loam, p. 91.

[b] Mapped as Vernon loam, but now brought into the proper place in the series.

Sedgwick black clay loam.—The soil is a fine-grained black silty loam, 12 inches deep, underlain by a tough, heavy, bluish-gray to drab clay extending to a depth of 3 feet or more. The type occupies flat or depressed areas on upland prairie and is poorly drained. The soil is formed by the wash from the surrounding soils. It is generally used only for pasture, although thorough drainage converts it into a soil well adapted to wheat and corn.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	8	31	48	9
Subsoil (1)	0	1	1	1	15	52	31

	Acres.
Wichita, Kans.	5,568

SOILS OF THE GREAT BASIN.

With the exception of one soil type recognized in the Laramie area, Wyoming, the soils in this group, so far as mapped, are confined to the Great Interior Basin region. They are derived from a great variety of rocks, and consist of colluvial soils of the mountain slopes, deep lacustrine and shore deposits of the Bonneville period, and of recent stream valley sediments and river delta deposits.

When not situated above or outside the limits of irrigation, or rendered unfit for cultivation by accumulation of alkali or seepage waters, they are of great agricultural importance, and are devoted mainly to the production of grains, sugar beets, alfalfa, stone or other tree fruits, and vegetables.

BINGHAM SERIES.

This series covers lower mountain slopes, upper valley slopes, and valley plains. It consists of colluvial mountain wash or of old alluvial torrential or intermittent streams, delta cone deposits, or of a mixture of these materials. The soils are usually gravelly and generally treeless, except in the immediate vicinity of stream courses. The more elevated areas are frequently rough and hilly and marked by the presence of rock outcrop and bowlders. They are frequently cut by washes or intermittent stream channels and are well drained, except in the lower-lying areas occupying depressions.

These soils are derived principally from eruptive, early sedimentary, and altered sedimentary rocks of all ages, and modified particularly by material derived from limestone, granites, shales, slates, etc. They occur as irregular and frequently extensive bodies, often lying above the limits of irrigation. When capable of irrigation, the soils are often well adapted to peaches and other fruits.

Bingham stony loam.—The soil is a sandy loam or fine sandy loam, generally of a dark or drab color and loose, porous structure, typically 4 to 6 feet deep, containing gravel, stones, and bowlders, and is underlain by gravel beds or bowlders, or by rock, which frequently outcrops upon the surface. The type occurs along lower mountain slopes, high terraces, and elevated parts of old alluvial delta cones, and has a sloping and frequently rough or hilly surface. It is well drained and free from alkali salts. It has been formed by colluvial mountain wash and by sedimentary material deposited by intermittent, shifting streams or mountain torrents, and occupies irregular and sometimes extensive areas. The soil has little agricultural value at present, being too stony, and usually lying too high for irrigation. But for this disadvantage of position in most areas and the scarcity of water in others, some areas of this soil might be used in fruit growing.

	Acres.		Acres.
Bear River, Utah	1,984	Sevier Valley, Utah	16,600
Provo, Utah	a 33,728	Weber County, Utah	5,700
Salt Lake, Utah	4,210		

Bingham gravelly loam.—The soil is a sandy loam or fine sandy loam of open, porous structure and dark or drab color, generally from 18 inches to 6 feet or more in depth, usually underlain by gravel, bowlders, or rock. It occurs as extensive areas covering lower mountain slopes, upper valley slopes, and sloping alluvial delta cone plains, generally lying slightly below areas covered by the Bingham stony loam, to which it is similar in origin and mode of formation. Flat shaly to well-rounded gravel varying in size from fine fragments to 3 or 4 inches in diameter occurs either upon the surface or within a depth of 3 feet. The surface is generally free from rock outcrop or bowlders and is well drained and free from alkali. The type frequently lies above the limits of irrigation and is sometimes dry-farmed to grains. Where capable of irrigation, it is frequently well adapted to truck crops and orchard and small fruits.

a Mapped as Maricopa stony loam.

	1	2	3	4	5	6	7
Soil (12)	2	3	5	12	26	33	16
Subsoil (4)	3	6	5	19	27	26	10

	Acres.		Acres.
Bear River, Utah	10,304	Salt Lake, Utah	35,280
Provo, Utah	[a]48,128	Sevier Valley, Utah	38,400

Bingham loam.—The soil is a dark or drab loam, usually 4 feet in depth, underlain by a clay loam subsoil. The type is similar to the Bingham gravelly loam in origin and mode of formation, but is composed of finer alluvial and colluvial material, is further removed from the mountains, and occupies lower levels and depressions. Drainage is often poor and the soil contains considerable alkali, but when drained and free from alkali it is excellent for general farming purposes.

	1	2	3	4	5	6	7
Soil (2)	1	1	1	5	11	46	28
Subsoil (3)	2	2	2	7	15	45	24

	Acres.
Sevier Valley, Utah	[b]12,100

REDFIELD SERIES.

The Redfield series extends from mountain bases across plateaulike plains, upper valley slopes, and sloping plains of narrow valleys to nearly level plains adjacent to the valley trough. The soils of this series are formed of colluvial mountain wash, or sometimes of residual material, mingled with alluvial delta cone deposits of intermittent or torrential streams. They are generally treeless, often gravelly, sometimes marked by rock outcrop, and frequently cut by washes and intermittent stream channels. The soils are derived primarily from red sandstone modified in places by an admixture of material derived from shales, slates, eruptive rocks, etc., and are typically of vermilion or bright red color. They generally occur as extensive areas. The lower lying and heavier members of the series are often poorly drained and alkaline.

Redfield fine sandy loam.[c]—The soil is a fine sandy loam, 6 feet in depth, derived from the disintegration of red sandstones, sometimes mingled with limestones, and is usually well drained. In some areas the soil contains well-rounded, medium-sized gravel within 3 feet of the

[a] Mapped as Maricopa gravelly loam.

[b] Mapped as Glenwood loam.

[c] Mapped as Redfield sandy loam.

surface, and this gravel increases in quantity and size in the lower depths. Some areas are underlain by sandstone and limestone rocks outcropping in high places. The type occupies valley floors sloping gently from the mountains, upper bench lands, and elevated, undulating plains. It is adapted to alfalfa and grain when so situated that irrigation is possible.

	1	2	3	4	5	6	7
Soil (5)	1	4	3	24	33	27	11
Subsoil (13)	0	3	4	15	31	35	13

	Acres.
Sevier Valley, Utah	44,200
Laramie, Wyo	42,644

Redfield loam.—The soil is a vermilion-colored loam, 4½ or 5 feet deep, underlain by a clay loam or occasionally by a sandy loam or sand subsoil. The type occupies level valley floors and is frequently poorly drained and contains alkali. It is an excellent soil for general farming when drained and free from alkali.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	8	16	52	22
Subsoil (4)	0	1	1	6	17	49	22

	Acres.
Sevier Valley, Utah	14,100

Redfield clay loam.—The soil is a clay 5 feet in depth, of vermilion-red color, underlain by a sand subsoil. The soil is quite tenacious and difficult to till. The type occupies low and level land, is poorly drained, and contains considerable alkali. The soil is of little agricultural value except as meadow land.

	1	2	3	4	5	6	7
Soil (2)	1	1	1	2	9	54	28
Subsoil (4)	0	0	1	2	10	53	33

	Acres.
Sevier Valley, Utah	3,800

MALADE SERIES.

This series occurs along valley troughs and in the vicinity of river flood plains, and consists of stream sediments of recent date or in process of formation. The soils occupy low or slightly elevated valley plains of smooth, nearly level surface, frequently marked by the presence of stream channels or sloughs. They are derived mainly from eruptive, early sedimentary, and altered sedimentary rocks, and occur as small narrow to broad extensive areas. The soils are generally dark in color and are underlain by light-colored sands or sandy loams or by heavy red subsoils. The heavy members are compact. The areas are generally well drained.

Malade fine sand.—This consists of a fine sand without much change in texture to a depth of 6 feet. It has been formed from materials deposited by river overflows, and is usually found adjacent to the stream channels, sometimes occupying the higher forelands. It is adapted to sugar beets under irrigation and to other crops suited to the climatic conditions.

	1	2	3	4	5	6	7
Soil (3)	0	1	7	50	28	8	7
Subsoil (1)	0	0	0	35	39	16	10

	Acres.
Bear River, Utah	6,080

Malade sandy loam.—The soil consists of a fine sandy loam to a depth of about 12 inches, and is underlain to 5 or 6 feet by a coarse sandy loam subsoil often containing a high percentage of clay, and this in turn is underlain by a fine sandy loam or fine sand. The surface foot is usually quite loose in texture, but below this the material is generally very compact. The type owes its origin to river deposits. The surface is level, but is higher than surrounding land, the type usually occupying forelands adjacent to the streams. The soil is well drained and free from alkali, and is well adapted to alfalfa, grasses, wheat, and other grain crops. It is an excellent soil for sugar beets when irrigation is practiced.

	1	2	3	4	5	6	7
Soil (1)	0	0	1	46	23	19	20

	Acres.
Bear River, Utah	3,264

Malade fine sandy loam.—The soil is a gray fine sandy loam to a depth of from 2 to 2½ feet, underlain to 6 feet with a red loam or clay loam subsoil. The heavy subsoil has been deposited in quiet waters from silt and clays brought down by river overflows, while the top covering of fine sandy loam has been formed colluvially from surrounding higher lands. The type is generally well drained, and contains very little alkali, the subsoil being comparatively free from it. The soil is adapted to sugar beets, alfalfa, and to some orchard fruits.

	1	2	3	4	5	6	7
Soil (3)	0	0	1	16	31	37	16
Subsoil (3)	0	0	0	11	23	40	25

	Acres.
Bear River, Utah	10,112

Malade loam.—To a depth of about 12 inches this is a fine sandy loam soil, underlain to 3 or 4 feet by a loam or occasionally by a clay loam subsoil, which is in turn underlain to 6 feet by a fine sandy loam, fine sand, sandy loam, or sand. The type has been formed by deposits from river flood waters. The surface is generally level, and the soil is naturally well drained, except where it lies adjacent to streams. Where free from alkali it is well adapted to sugar beets and grain, and where the water table is not too near the surface, to fruit and alfalfa.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	13	25	43	17
Subsoil (3)	0	1	1	12	24	33	29
Lower subsoil (1)	0	0	0	32	43	14	11

	Acres.
Bear River, Utah	16,640

JORDAN SERIES.

The Jordan series consists of old stream sediments, probably deposited to a large extent in the waters of former lakes and modified by later shore and stream deposits. It thus consists of a mixture of stream and lacustrine sediments and occurs upon low, level or sloping valley plains covering the bed, benches, and shores of ancient Lake Bonneville. The soils are not subject to present extensive stream modification and are treeless except in the vicinity of streams or lakes. With the exception of the lower lying bodies the soils are usually well drained. The material is derived from a great variety of rocks of all ages, consisting of lavas, sandstones, shales, limestones, slates, quartzites, granites, etc. The soils occur as irregular and frequently as extensive areas, with the exception of the members of lighter texture, and are dark in color and agriculturally important, except where poorly drained and alkaline. They are generally devoted to grain, alfalfa, fruits, and truck crops.

Jordan sand.[a]— The soil is a medium to rather fine sand of light-gray color, and loose, incoherent structure generally 6 feet or more in depth. The lower portion of the section is sometimes coarser in texture than the

[a] See also Jordan fine sand, p. 191.

overlying material. The type occurs as small, narrow to broad extensive areas covering low, level to somewhat elevated, and sloping valley plains. The more elevated areas are well drained, often of uneven surface, and frequently gravelly, supporting only desert vegetation. The lower lying areas are sometimes poorly drained and somewhat alkaline. The type is formed of assorted stream-borne material, probably deposited subsequent to the Bonneville period.

	1	2	3	4	5	6	7
Soil (5)	2	13	13	42	15	7	7
Subsoil (4)	1	3	8	36	23	19	9

	Acres.
Provo, Utah	[a] 10,368
Weber County, Utah	[a] 21,800

Jordan fine sand. [b]—This is a sand of light color, fine texture, and loose, incoherent structure, usually 6 feet or more in depth, but sometimes less, overlying sandy loam or loam. The type usually occurs as small, narrow, or irregular and extensive areas often occupying a somewhat elevated position. The surface is often barren and marked by irregularities and drifting dunes. The soil is well drained and free from alkali, but generally of little agricultural importance.

	1	2	3	4	5	6	7
Soil (1)	0	4	13	60	18	1	4

	Acres.
Weber County, Utah	1,900
Salt Lake, Utah	3,020

Jordan fine sandy loam. [c]—This consists of a sandy loam of medium to fine texture, generally from 1 to several feet in depth. The subsoil is subject to considerable variation, but the soil is generally underlain at about 2 feet by about 1½ feet of loam, then by 1 foot of fine sand grading into clay. It usually occupies lower valley plains and is an important agricultural soil where well drained and free from alkali.

	1	2	3	4	5	6	7
Soil (7)	1	2	7	20	26	28	13
Subsoil (4)	1	1	1	6	37	34	16

	Acres.
Salt Lake, Utah	18,620

[a] Mapped as Fresno sand.

[b] Mapped as Jordan sand.

[c] Mapped as Jordan sandy loam.

Jordan loam.[a]—The soil consists typically of 3 or 4 feet of loam underlain by a clay subsoil. Occasionally, however, the surface to the depth of from 1 to 2½ feet is a fine sandy loam. The lower portion of the soil section is also subject to considerable variation, the loam sometimes extending to a depth of 6 feet or more, while layers or lenses of sand often occur in the subsoil. The type generally occurs as isolated and rather small bodies covering parts of the lower level valley plains, depressions, or lower benches. The lower lying areas are generally poorly drained and alkaline.

	1	2	3	4	5	6	7
Soil (11)	1	1	2	7	22	37	26
Subsoil (12)	2	2	2	7	18	38	25

	Acres.
Provo, Utah	[b] 38,400
Salt Lake, Utah	41,900
Weber County, Utah	15,400

Jordan clay loam. [c]—This consists of a dark-gray or sometimes reddish clay loam soil usually extending to a depth of about 3 feet. The soil is often friable, resembling in field characteristics a soil of much lighter texture. The subsoil is sometimes a sandy loam, but is usually a heavy clay loam or clay of yellow or red color. The type occurs as extensive areas covering lower level valley plains or lower benches. The lower lying areas are often poorly drained, alkaline, and of a compact structure, making them difficult to cultivate. The soil produces alfalfa, grain, and sugar beets.

	1	2	3	4	5	6	7
Soil (4)	1	1	4	2	14	45	34
Subsoil (3)	0	0	0	1	7	39	53

	Acres.
Provo, Utah	99,648
Bear River, Utah	61,632

Jordan clay.[d]—This consists of about 1 foot of heavy clay loam or clay underlain to 6 feet or more by a tenacious clay subsoil, usually of light-yellowish color. The subsoil is sometimes marked by thin strata or lenses of sand or fine sand. The type occurs upon valley plains extending from lower limits of the mountain slopes to recent lake bottoms. The more elevated areas are generally well drained and com-

[a] See also Jordan clay loam, p. 192.

[b] Mapped as Jordan sandy loam.

[c] Mapped as Jordan loam.

[d] See also Salt Lake clay loam, p. 194.

prise valuable farming lands. The lower lying areas are generally poorly drained, alkaline, and of but little agricultural importance.

	1	2	3	4	5	6	7
Soil (4)	0	1	1	5	13	30	52
Subsoil (2)	0	0	0	8	20	39	35

	Acres.
Bear River, Utah	2,688
Provo, Utah	3,840

SALT LAKE SERIES.

The Salt Lake series consists of lacustrine sediments and material derived from stream deltas. The soils of this series occur upon low, level plains, marking the site of recent lake bottoms. They are generally barren, deficient in drainage, and heavily impregnated with alkali salts. They are derived from eruptive, sedimentary, and altered rocks of various ages and are without gravel. They cover extensive areas, are usually dark in color, and usually have little or no agricultural importance.

Salt Lake sand.—This is a sand consisting of about 80 per cent of medium-sized egg-shaped or spherical particles, largely calcareous. The type occupies level or dune areas. Near Great Salt Lake, Utah, the type is derived from the breaking up of lime hardpan, the peculiar and regular shape of the particles resulting from the wearing and polishing action of wind and water. As found in the vicinity of Great Salt Lake the soil is of no agricultural value, because of its limited extent and its position.

	1	2	3	4	5	6	7
Soil (2)	1	15	49	27	5	1	2

	Acres.
Provo, Utah	1,152
Salt Lake, Utah	1,140

Salt Lake sandy loam.—This type consists of from 18 inches to 2 feet of sandy loam soil underlain by a fine sand subsoil, or of 6 feet of loam interstratified with beds or lenses of fine sands, fine sandy loams, or light loams. It occupies level plains and recent lake bottoms. The soil is poorly drained, contains an excess of alkali, and is bare of vegetation. For these reasons it has no present agricultural value.

	Acres.
Bear River, Utah	1,408
Weber County, Utah	49,900

Salt Lake loam.—The soil consists of 2 to 3½ feet of loam, generally containing a large amount of fine sand or silt, usually underlain to a depth of 6 feet or more by a fine sand, fine sandy loam, or sandy loam subsoil. It occupies level plains, representing recent lake bottom, is poorly drained, and contains excessive amounts of alkali. The soil is not adapted to agriculture at present, on account of its low-lying position, imperfect drainage, and high salt content.

	1	2	3	4	5	6	7
Soil (2)	1	1	1	10	27	37	25
Subsoil (3)	0	1	1	20	41	20	12

	Acres.
Bear River, Utah	6,912
Provo, Utah	3,456
Weber County, Utah	9,600

Salt Lake clay loam.—This is a loam containing a relatively large quantity of silt, generally 6 feet or more in depth and becoming somewhat heavier in texture and structure in the lower portion of the section. The type covers large areas of recent lake bottom. The areas are low, level, and poorly drained, and are frequently marked by the presence of meandering sloughs and stream courses. The soil is generally filled with alkali and is of but little agricultural importance, only small areas being devoted to hay and grazing.

	1	2	3	4	5	6	7
Soil (6)	1	1	1	4	20	43	25
Subsoil (5)	5	3	2	8	12	35	35

	Acres.
Bear River, Utah	70,656
Salt Lake, Utah	[a] 18,510

MISCELLANEOUS SOILS OF THE GREAT BASIN.

Elsinore sand.—This type consists of rather coarse sand of light color and porous structure, generally carrying considerable waterworn gravel, extending to a depth of 6 feet or more. It is usually underlain by gravel beds. The type occupies recent stream sediments covering narrow areas in the vicinity of stream channels and is derived from a variety of rock material transported for considerable distances by valley streams. The soil is well drained, but is of little agricultural importance.

	Acres.
Sevier Valley, Utah	1,900

[a] Mapped as Jordan clay.

Elsinore fine sandy loam.—The soil is a light-colored fine sandy loam 4 feet in depth, underlain by a coarse sand subsoil grading into gravel. The type occupies low, level parts of the Sevier Valley, Utah. It is derived from river-transported material, is poorly drained, and contains considerable alkali near the surface. At present the soil is adapted only to salt-grass meadows.

	1	2	3	4	5	6	7
Soil (5)	0	2	3	15	30	37	12
Subsoil (5)	2	3	4	27	30	25	8

	Acres.
Sevier Valley, Utah	[a] 7,800

Weber fine sandy loam.[b]—The soil is rather sticky and heavy fine sandy loam of dark color, usually 6 feet or more in depth. Where less than 6 feet deep, it is generally underlain by a sand or sandy loam subsoil. The type occurs as extensive areas from the base of mountain slopes to recent lake bottoms, or as low, level, or slightly sloping recent stream delta deposits. In the vicinity of recent lake or lagoon bottoms it sometimes occurs as small mounds or elevations from a few to 20 feet high. The lower lying areas are often poorly drained and filled with alkali.

	1	2	3	4	5	6	7
Soil (10)	1	2	4	17	33	25	8
Subsoil (7)	1	1	5	35	28	17	12

	Acres.
Bear River, Utah	21,504
Weber County, Utah	86,400

SOILS OF THE NORTHWESTERN INTERMOUNTAIN REGION.

The most extensive and uniform soil types of this region consist of residual materials overlying and derived from extensive basaltic lava plains and in some cases from granitic rocks or of ancient lacustrine sediments or extensive lake beds now more or less modified by erosion or æolian agencies. Owing to erosion by streams and to movements of the earth's crust, these soils now generally occupy more or less elevated sloping or rolling plains. About the margins of the lacustrine or residual deposits they are covered by sloping plains and fans of colluvial wash from the adjacent mountain borders, while in the vicinity of the

[a] Mapped as Elsinore sandy loam.

[b] Mapped as Fresno fine sandy loam. A part of the type should have been mapped as Bingham gravelly loam.

larger streams, which have carved and terraced the lacustrine beds and residual soils, occur other series of recent alluvial stream sediments derived from reworked materials of the lake beds or from the weathered products of the mountains. It is the soils of this region that constitute a large portion of the great grain-producing lands of the Northwest.

BRIDGER SERIES.

The soils constituting this series occur upon mountain foot slopes, lower foothills, high or sloping plains, mesa lands, and alluvial fans or fan deltas, and consist of colluvial mountain waste mixed with stream-delta cone deposits. The higher lying areas are often rough and hilly, marked by rock outcrop, bowlders or glacial morainic débris, and deeply cut by stream channels. The soils are generally treeless or sparsely timbered, except in the vicinity of streams. The members of this series are derived from granitic rocks, gneiss, basaltic, andesitic, or other volcanic rocks, with an admixture of materials derived from sedimentary rocks and occupy small, irregular to broad extensive areas. The soils are generally of dark color, and are underlain by sticky subsoils of light-gray or yellow color. The soils and subsoils are generally gravelly, the gravel varying from fine angular chips to large, well-rounded or angular blocks and cobbles. The soils are dry farmed to grains or, when not occupying too high a position, are irrigated and devoted to grains, alfalfa, clover, and fruits.

Bridger gravelly loam.—This consists of a rather fine sandy loam or loam from 1 to 3 feet deep, carrying an appreciable amount of coarse, sandy material composed of fine angular rock fragments, giving it a somewhat loose porous structure. The soil is generally underlain by a sticky, compact subsoil of fine texture and lighter color, although in the vicinity of canyon streams it is sometimes underlain by gravel and bowlders. The type occurs as small local to broad extensive areas covering mountain foot slopes and alluvial cones and fans. The surface is frequently dissected by minor streams, broken by rock outcrop, or marked by glacial débris and bowlders. The soil and subsoil are generally gravelly, the gravel consisting of angular to partially rounded fragments. The soil is well drained and free from alkali, but is generally somewhat deficient in organic matter. It is dry farmed to grains and when irrigated produces grain, alfalfa, and fruits.

	Acres.
Baker City, Oreg.	[a] 17,216
Gallatin Valley, Mont.	12,544

[a] Mapped as Maricopa gravelly loam.

Bridger loam.[a]—This type consists of a loam, sometimes approaching a fine sandy loam of rather loose porous structure, from 12 to 24 inches deep, underlain by a gritty subsoil of lighter color, compact structure, and heavy texture. Fine angular gravel frequently occurs. In the subsoil this is sometimes cemented together with a calcareous material, forming a hardpan. The type occurs upon mesa lands and lower foot slopes and is well drained and free from alkali. Under irrigation it is adapted to the production of alfalfa, clover, timothy, grains, and fruits.

	1	2	3	4	5	6	7
Soil (3)	2	5	3	12	17	50	12
Subsoil (3)	4	9	5	15	15	38	15

	Acres.
Baker City, Oreg	30,784

Bridger clay loam.—The soil is a dark-colored to black tenacious clay loam from 1 to 3 feet in depth, of a fine silty texture, and frequently of compact, adobelike structure, usually carrying considerable fine angular gravel. The subsoil is a tenacious silty clay loam of light-yellow to gray color, frequently carrying large amounts of lime. The type occurs as irregular areas covering parts of sloping terraces adjacent to mountain ranges, foothills, and foot slopes. The soil is generally retentive of moisture, and is productive either when dry farmed or irrigated.

	1	2	3	4	5	6	7
Soil (1)	0	2	1	4	10	58	26
Subsoil (2)	1	2	1	4	11	50	32

	Acres.
Gallatin Valley, Mont	1,472

YAKIMA SERIES.

The members of this series consist of ancient lake sediments, with an admixture of volcanic dust or of residual soils of fine texture or a mixture of both. The materials have been derived mainly from basaltic and andesitic or granitic rocks. The soils occur upon mountain foot slopes, elevated lava plateaus, table-lands, ridges, or rolling hills, with intervening depressions, sloping valley plains, and elevated stream terraces. The higher areas are often rough and broken and are marked by rock outcrop and forest growth. The lower lying areas are generally gently sloping or undulating, dissected by minor stream channels, and

[a] Mapped as Maricopa sandy loam.

marked by bluff and terrace lines usually strewn with waterworn gravel. The soils of this series generally occur as extensive areas. Both soils and subsoils are of a light-gray to light-brown or buff color, usually porous structure, and ashy texture from a few to many feet in depth. A thin layer of compact adobelike structure sometimes occurs in the subsoils, which are underlain by parent rock or by gravel beds occurring at considerable depths. The soils usually erode rapidly under the influence of streams or irrigation. The subsoils are frequently marked by the presence of pockets of volcanic ash and are friable and easily cultivated. The soils are well drained and productive and are extensively cultivated to grains, hay, hops, and vegetables.

Yakima stony loam.—This type consists of basaltic ledges, bowlders, and gravel outcrops generally in too great quantity to permit of cultivation. The space between the bowlders is occupied by small patches of Yakima sandy loam. The type occurs on hillsides and plateaus in valleys and is well drained and free from alkali. The bowlders are sometimes removed and the soil cultivated.

	Acres.
Yakima, Wash	8,960

Yakima sand.—This type consists of a gray to dark-gray sand of medium texture, usually 1 to 6 feet or more in depth, underlain by a sandy loam of the same composition as the Yakima fine sandy loam. The type occurs in extensive bodies, occupying ridges, hillocks, and dunes, with intervening narrow depressions. The soil is frequently drifted badly by winds. It is well drained and free from alkali. The type is derived mainly from basaltic rocks, the finer material having been removed by winds. It is difficult to cultivate on account of its high position, porous structure, and driftin .

	1	2	3	4	5	6	7
Soil (1)	1	18	23	39	12	4	3

	Acres.
Blackfoot, Idaho	31,104

Yakima fine sand.[a]—This is a fine sand of loose porous structure, from a few inches to several feet in depth. It is similar to the Yakima sand in color, topographic position, origin, and mode of formation, but is generally somewhat less drifted. The soil is well drained, free from alkali, and when capable of irrigation and cultivation is adapted to tree fruits, truck crops, berries, alfalfa, and clover.

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[a] See also Gallatin fine sandy loam, p. 202.

	1	2	3	4	5	6	7
Soil (3)	1	2	6	45	28	15	4
Subsoil (2)	1	1	2	19	50	21	5

	Acres.
Boise, Idaho	[a] 17,430
Yakima, Wash	[b] 20,660

Yakima fine sandy loam. [c]—This consists of a gray fine sandy loam of a light friable structure from a few inches to many feet in depth. Alternating strata of fine sand and fine sandy loam, with occasional gravel, often occur throughout the lower portion of the soil section. Where the soil is shallow it is directly underlain by basaltic rock. Strata of volcanic ash frequently occur at varying depths throughout the soil section as beds from a few inches to 2 feet in thickness. The type generally occurs as extensive bodies covering ridges or hilltops, elevated slopes, and valley plains. On account of its friable, porous structure it is easily washed by streams. The type consists primarily of preglacial lake sediments, the surface often being strewn with glacial gravel and bowlders. The soil is well drained and free from alkali, except where subject to seepage from more elevated lands, and is adapted to hops, alfalfa, clover, timothy, fruits, and cereals.

	1	2	3	4	5	6	7
Soil (2)	2	4	5	14	29	39	7
Subsoil (5)	1	2	4	14	29	42	7

	Acres.
Yakima, Wash	[d] 149,580

Yakima loam. [e]—The soil consists of a light loam of fine silty texture and porous structure, approaching a fine sandy loam in field properties, of a light-brown to buff or gray color, generally extending to a depth of from 2 to 4 feet. The subsoil is a yellow to light-brown rather compact loam in residual areas, grading into decomposing crystalline rocks. Rock fragments are encountered in both soil and subsoil. The type consists mainly of residual or colluvial material derived from granitic or basaltic rocks, covering rough hills or gently sloping foot slopes and plains. The higher lying bodies are often forested

[a] Mapped as Snake River sand.

[b] Mapped as Sunnyside sand.

[c] See also Columbia silt loam, p. 206, and Yakima silt loam, p. 200.

[d] Mapped as Yakima sandy loam.

[e] Mapped as Yakima sandy loam. See also Gallatin loam, p. 203.

and little cultivated, owing to the rough character of the surface. The soil is well drained and free from alkali, and where capable of cultivation is well adapted to alfalfa, timothy, clover, and grains.

	1	2	3	4	5	6	7
Soil (3)	2	5	4	12	12	49	13
Subsoil (2)	1	1	2	11	15	62	9

	Acres.
Baker City, Oreg	10,816
Lewiston, Idaho	6,208

Yakima silt loam.[a]—This type consists of a buff to light-brown silt loam, 6 feet deep, often containing a layer of brown silt loam of compact adobelike structure from a few to 10 inches in thickness. This compact stratum erodes less easily than the overlying soil or the subsoil, but offers little hindrance to cultivation or root penetration. Upon the steeper slopes the soil is often of somewhat lighter color and looser structure than over the more nearly level bodies. The soil is sometimes of a somewhat compact structure with slight puddling tendencies, but is generally friable under ordinary cultivation. It is underlain generally by a friable and often distinctly porous and ashy subsoil of yellow, light-gray, or buff color and fine silty texture, frequently rich in lime and containing small pockets of volcanic ash. The type usually occurs as extensive bodies covering rolling hills and intervening narrow valleys, mounds, ridges, or elevated sloping treeless plains and mesa lands frequently deeply dissected by intermittent streams. The material consists of ancient lake deposits, derived mainly from basaltic and other volcanic rocks partially reworked or modified by subsequent stream wash, or in certain cases derived from deep weathering of basaltic or crystalline rocks in place. The surface is frequently marked by bluff or terrace lines, which are usually thickly strewn with waterworn gravel. The soil is deficient in organic matter, but is usually well drained, free from alkali, and productive, being devoted mainly to grains, alfalfa, and clover.

	1	2	3	4	5	6	7
Soil (9)	0	0	0	3	18	70	9
Subsoil (7)	0	0	0	2	9	79	10

	Acres.
Gallatin Valley, Mont	53,824
Lewiston, Idaho	[b]172,992
Walla Walla, Wash	[c]64,896

[a] See also Gallatin silt loam, p 203.
[b] Mapped as Yakima fine sandy loam.
[c] Mapped as Yakima sandy loam.

GALLATIN SERIES.

The Gallatin series occupies lower, nearly level, or slightly sloping stream terraces or alluvial river valley plains adjacent to stream channels. The soils of this series are formed by recent flood-plain deposits with an admixture of reworked lake sediments. They are underlain by beds of gravel and cobbles, usually at a depth of from a few inches to a few feet, sometimes partially cemented by lime. The areas are often marked by shallow beds or channels of meandering streams, and are frequently timbered or covered with willow or brush thickets in the vicinity of streams. The members of this series are derived mainly from basaltic, andesitic or other volcanic rocks, with an admixture of material derived from granites, gneiss, sedimentary, or altered sedimentary rocks. They usually occur as small irregular to broad extensive areas. The lighter members are of a light-gray color and porous structure, and are usually gravelly, the gravel consisting of well-rounded pebbles. The heavier members are brown to black in color, compact in structure, usually poorly drained, are sticky when wet, and have a tendency to puddle. The areas are often subject to overflow. The soils are underlain by light-gray or yellowish ashy to dark compact subsoils with frequent occurrences of a compact adobelike structure. They are generally rich in organic matter and of a mucky consistency, except in the lighter, higher lying members. The soils sometimes contain alkali, and are generally devoted to hay, grains, vegetables, and pasture.

Gallatin gravelly loam.—The soil is a rather compact, moderately heavy, and sticky loam of dark-gray to dark-brown color, varying from a few inches to 3 feet in depth and carrying a large amount of flattened or rounded gravel, chiefly of basaltic or other volcanic rocks, from a fraction of an inch in diameter to the size of cobbles. The surface is often, but not always, strewn with cobbles and gravel. The soil is underlain by a sticky, gravelly loam of fine texture and light-gray color, grading to gravel beds, or frequently underlain directly by beds of river sands and reworked pebbles and cobbles often partially cemented by lime. The type generally occurs as extensive areas covering nearly level or slightly sloping stream flood plains or valley bottoms skirting stream channels. The surface is broken only by shallow stream channels or minor stream-formed terraces and is frequently covered by heavy thickets of willow and light timber. The soil is well drained, except in the level areas, which are subject to overflow. The type is formed by a mixing of recent stream alluvium with original gravel sheets underlying lake beds. The soil is frequently too shallow and gravelly to admit of profitable cultivation, but the favorably situated areas are adapted to grains and hay.

	1	2	3	4	5	6	7
Soil (2)	3	6	6	16	19	42	9

	Acres.
Gallatin Valley, Mont	32,576
Walla Walla, Wash	[a] 10,048

Gallatin fine sandy loam.—This type consists of a light-brown to light-gray fine sandy loam, rather light in texture, grading toward a fine sand. The soil has a loose, friable structure to a depth of from 1 to 6 feet, and is usually underlain by a gray or light-colored fine sandy or silty subsoil, often containing small well-rounded gravel which grades into beds of river sands and gravel. The sand and gravel beds sometimes underlie the soil directly. The type occurs in small, irregular to broad, extensive areas, covering valley plains and low, nearly level to slightly elevated and sloping stream terraces. The surface is generally smooth, except in the vicinity of bluff or terrace lines or where cut by stream channels, and is treeless. The soil is often strewn with waterworn gravel or slightly drifted by winds. It is seldom subject to overflow, and is generally well drained and free from alkali, except when subject to seepage from more elevated soils. Stream sediments are sometimes mingled with the earlier lake deposits. The soil is often somewhat deficient in organic matter. Under irrigation it is adapted to trees and small fruits, truck crops, grains, alfalfa, and clover.

	1	2	3	4	5	6	7
Soil (4)	0	2	5	26	30	31	6
Subsoil (4)	1	6	7	28	20	29	8

	Acres.
Boise, Idaho	[b] 33,100
Gallatin Valley, Mont	6,464
Lewiston, Idaho	[c] 2,112

[a] Mapped as Yakima gravelly loam.
[b] Mapped as Caldwell sandy loam.
[c] Mapped as Yakima fine sand.

Gallatin loam.[a]—This type consists of a dark-gray or brown to dark-brown or nearly black loam, from 3 to 6 feet deep, of a fine silty texture and friable under cultivation. The soil is underlain by a gravelly loam or waterworn gravel or by a gray or yellow sticky loam grading into gravelly loam or river gravel. The lighter phases are frequently of porous structure and ashy texture. The type occupies extensive areas covering low-lying plains or terraces and stream flood plains, and is subject to overflow and sometimes poorly drained. Both soil and subsoil are sometimes marked by pockets of volcanic ash. The type is composed of recent stream alluvium with an admixture of older degraded lacustrine material. The soil is generally rich in organic matter, and in the poorly drained districts is sometimes filled with alkali. Where cultivated it is adapted to vegetables, hay, and grain.

	1	2	3	4	5	6	7
Soil (6)	0	2	2	13	24	43	16
Subsoil (6)	2	4	3	15	20	39	19

	Acres.
Baker City, Oreg	29,760
Blackfoot, Idaho	241,216
Walla Walla Wash	3,392

Gallatin silt loam.—The soil of this type is a dark-gray or brown to black heavy sticky silt loam, sometimes containing gravel. It has rather a compact structure, but is generally friable under cultivation. The soil is from 10 to 36 inches deep, and is underlain by a dark-gray or black to light-colored heavy, sticky silty loam, generally of rather compact adobelike structure, which usually extends to a depth of 6 feet or more, and is in turn underlain by rounded river gravels. The type occupies small to extensive areas covering nearly level valley depressions, river flood plains, and stream bottoms. The areas are often marked by willow thickets or small timber and are cut by meandering stream channels. The soil is often subject to overflow, is usually poorly drained, and sometimes contains alkali. The type is composed of stream sediments derived from rocks of adjacent mountains and by degradation and reworking of earlier lake beds. The soil is generally rich in organic matter and is frequently of a somewhat mucky consistency. It is devoted to pasture, hay, grains, vegetables, and forage crops.

[a] Mapped as Yakima loam.

	1	2	3	4	5	6	7
Soil (6)	0	2	2	5	9	66	16
Subsoil (6)	0	1	1	8	15	62	15

	Acres.
Boise, Idaho	[a] 1,500
Lewiston, Idaho	[b] 15,936
Gallatin Valley, Mont	23,808

Gallatin clay loam.—This type consists of a dark chocolate-brown heavy sticky clay loam soil of compact adobelike structure, generally about 3 feet in depth, and underlain by a heavy silty clay loam subsoil of lighter color, or by waterworn gravel. The soil puddles readily, bakes and cracks upon exposure, and frequently carries small angular rock fragments. The type occurs as small bodies occupying local depressions in the vicinity of the valley trough and is often poorly drained. It is composed of heavy stream alluvium, partially derived from the reworking of earlier lake beds. The soil is generally devoted to grains and hay.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	7	11	50	30
Subsoil (1)	0	2	2	15	17	39	24

	Acres.
Gallatin Valley, Mont	896

MISCELLANEOUS SOILS OF THE NORTHWESTERN INTERMOUNTAIN REGION.

Deer Flat fine sandy loam. [c]—This is a red, micaceous fine sandy loam from a few inches to 3 feet in depth. The subsoil is a sandy loam or sand from 50 to 100 feet deep. The type occurs in higher lying valley areas and has a generally level surface. The soil is free from alkali, but only a small proportion is cultivated, owing to lack of water for irrigation. It is a good soil for truck, grain, clover, and fruit.

	1	2	3	4	5	6	7
Soil (2)	1	3	2	8	49	27	9
Subsoil (3)	2	3	2	13	47	23	8

	Acres.
Boise, Idaho	45,380

[a] Mapped as Caldwell loam.
[b] Mapped as Yakima silt loam.
[c] Mapped as Deer Flat sandy loam.

Boise loam.—This type consists of a red or yellow loam from 6 inches to several feet in depth, underlain by alternating strata of sandy loam and sand, the latter often being cemented into a hardpan by calcium carbonate. The particles in the upper stratum of the soil are also usually cemented together, but not into a compact mass. The surface is generally covered with a coating of sandy loam of varying depth and having the texture of the Boise sandy loam. The type occurs in mesa plains, is derived from lake sediments, and often contains alkali. When the subsoil is broken up it is a good soil for grain, fruit, and alfalfa.

	1	2	3	4	5	6	7
Soil (1)	2	2	1	5	26	44	18
Subsoil (3)	4	5	3	9	24	35	18

	Acres.
Boise, Idaho	61,960

Boise silt loam.—The soil is a light-gray silt loam of a micaceous, loose, and ashy texture, from a few inches to 40 or 50 feet in depth. To a depth of 6 feet it is often interstratified with a loam or with sand or sandy loam lime hardpan, and in places the sandy loam extends to bed rock. The soil rests upon beds of coarse gravel and cobbles. The type is usually found on mesa lands, and is composed of lake sediments, probably derived from basalt. Some alkali occurs in local spots in the loam subsoil. The soil is well drained and is adapted to truck, grain, and clover. Where the hardpan is not very thick fruit and alfalfa do well.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	3	16	68	9
Subsoil (4)	5	8	4	9	15	46	11

	Acres.
Boise, Idaho	[a] 95,850

Bozeman silt loam.—The soil is a brown to nearly black, heavy sticky silt loam, generally of compact structure, usually about 1 foot in depth. When poorly drained a refractory, adobelike structure prevails and small puddled and barren spots occur. The subsoil consists of a dark-brown, sticky silty loam or clay loam of adobelike structure, underlain at 3 feet by stream gravel or by a light-yellow to light-gray silt loam of ashy texture. Medium fine to coarse rounded gravel and cobbles frequently occur in both soil and subsoil. The type occurs as

[a] Mapped as Boise sandy loam.

irregular and extensive areas upon treeless foot-slopes and elevated sloping plains and sloping to nearly level valley plains. The lower lying bodies are somewhat deficient in drainage and sometimes contain alkali. The type has been formed by a partial degradation of ancient lake sediments modified by an admixture of alluvial material derived from adjacent mountains and valley borders.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	1	8	72	18
Subsoil (1)	0	1	1	2	9	69	17
Lower subsoil (1)	0	1	1	2	14	64	19

	Acres.
Gallatin Valley, Montana	76,608

Columbia silt loam.—This is a light-gray silt loam of a friable ashy texture, resembling in field properties a fine sandy loam. The soil is usually 6 feet or more in depth, and sometimes contains hardpan in the lower part of the section. The type occupies extensive bodies covering rolling hills with intervening valleys and is usually but not always well drained. It is composed of ancient lake sediments modified by an admixture of fine volcanic material. It sometimes contains alkali in low, poorly drained sections. The soil is generally devoted to grains.

	1	2	3	4	5	6	7
Soil (5)	0	1	1	6	16	67	8

	Acres.
Walla Walla, Wash	[a] 26,688

Walla Walla silt loam.—This type consists of a very sticky brown or black silt loam or loam to a depth of 3 feet, underlain by a sandy loam similar to the subsoil of the Yakima sandy loam. In places the subsoil from 3 to 6 feet is a sticky yellow plastic sandy loam, but in most cases below 3 feet the soil is a sandy loam. The type occupies very high, steep hills. It is well adapted to wheat and barley, giving very large yields of both.

	1	2	3	4	5	6	7
Soil (3)	0	0	0	3	13	70	14
Subsoil (3)	0	2	1	3	15	67	11

	Acres.
Walla Walla, Wash	[b] 23,360

[a] Mapped as Yakima fine sandy loam.
[b] Mapped as Walla Walla loam.

SOILS OF THE ROCKY MOUNTAIN VALLEYS, PLATEAUS, AND PLAINS.

The soils of the Rocky Mountain valleys, plateaus, and plains are derived from a wide range of igneous, eruptive, metamorphic, and sedimentary rocks. The plateau and plain types occupy a more or less elevated position and have sloping, undulating, or irregular surface features. They are derived from underlying sedimentary rocks, or consist of the remnants of ancient extensive mountain foot-slope material, or of alluvial deposits along streams trenching and terrac'ng the sedimentary rocks of the plateaus and plains. The mountain slope and intermountain valley types consist of residual and colluvial deposits, or of ancient lacustrine or later stream sediments, occupying mountain foot slopes and narrow valleys.

The soils of the mountain slopes are usually of little agricultural value, owing to their rough surface, elevated position, and the consequent impracticability of irrigation. Those of the plateaus, valleys, and plains vary widely in economic importance, depending largely upon climatic features, topographic position, and water supply for irrigation. They range from grazing lands of nominal value to soils adapted to the most important and intensively cultivated fruit, melon, sugar beet, and other special crops.

LARAMIE SERIES.

The Laramie series occurs upon mountain foot slopes and high, broken, sloping or undulating plains. The surface is often gravelly or strewn with cobbles or bowlders, and is frequently cut by intermittent stream channels or marked by rock outcrop. Depressions or basins of intermittent lakes frequently occur. The soils consist of colluvial mountain waste modified by alluvial stream wash or glacial débris, and are derived from granitic rocks, gneiss, schist, quartzites, etc., with an admixture of material from sedimentary rocks. They occur as extensive areas of dark-colored soils, generally underlain by light-colored gravelly subsoils, and are well drained and free from alkali except for local poorly drained depressions.

Laramie gravelly loam.—The soil is a sandy loam of loose porous structure containing considerable coarse material and carrying a large quantity of rather small or medium gravel. It is usually from 2 to 3 feet in depth, of a yellowish or dark-gray color, and is underlain to 6 feet or more by light sandy loams, sand, and gravel. The subsoil consists largely of torrential stream deposits, the gravel ranging in size from small pebbles to bowlders, and resting upon sedimentary rocks. The type occupies elevated, nearly level to broken and hilly plains. It is well drained and free from alkali, but owing to its porous structure and topographic position it is of but little agricultural value save for grazing.

	Acres.
Laramie, Wyo	19,200

Laramie sandy loam.—The soil consists of a coarse sandy loam 2 to 6 feet deep, and is underlain by sand and gravel. Some gravel, generally quartz, sandstone, and limestone, occurs scattered through the surface soil. The type occupies uplands and is of colluvial origin. It is well adapted to general farm crops. Wheat yields from 20 to 30 bushels, oats from 30 to 50 bushels, potatoes from 100 to 175 bushels, and alfalfa about 4 tons per acre.

	1	2	3	4	5	6	7
Soil (2)	6	12	9	20	16	11	26
Subsoil (3)	4	11	9	21	12	16	27

	Acres.
Laramie, Wyo	86,272

COLORADO SERIES.

The soils of the Colorado series consist of colluvial and alluvial material of ancient mountain foot slopes, more or less modified by or mingled with recent alluvial wash and with residual material derived from underlying sandstones, limestones or shales. They occupy elevated undulating prairies or treeless plains, marked by occasional low, rounded ridges or hills, deep, narrow arroyos, or broad, gently sloping valleys. In eroded districts bluff or terrace lines, strewn with waterworn pebbles, and outcropping ledges of sedimentary rocks are frequent. The smaller stream valleys are often subject to overflow, and the uplands are frequently marked by depressions or local drainage basins. The transported material is derived largely from granitic and allied rocks of the Rocky Mountains. The soils and subsoils are generally of light-gray to reddish-brown or light-brown color, and frequently occur as extensive areas. They are generally productive under irrigation, but sometimes poorly drained and alkaline in depressions when subject to seepage from higher elevations.

Colorado gravelly loam.—The soil of this type consists of a gray to dark-colored heavy fine sandy loam or loam of fine silty texture, generally 6 feet or more in depth and including considerable gravel. The gravel consists of fragments of granite, shale, or sandstone ranging in size from small fragments to 5 or 6 inches in diameter and increasing in quantity as the base of the mountains is approached. The soil erodes easily, and in arroyos or cuts the subsoil often exhibits a compact, adobelike structure. The type occurs along mountain foot slopes and is formed largely of colluvial material. It is frequently found as pronounced hills and ridges and is well drained and free from alkali. It usually occupies elevations above the limits of irrigation.

	1	2	3	4	5	6	7
Soil (1)	2	3	2	16	16	51	10

	Acres.
Greeley, Colo	33,408

Colorado sand.—The soil is a medium to rather fine sand of generally loose-porous structure, and often of wind-blown drifting surface, but sometimes sticky and compact, owing to more complete weathering. It is light-gray to yellowish or reddish-brown in color and generally 6 feet or more in depth, although sometimes less about margins of areas where it is blown over adjacent soil types. The soil is usually, but not always, free from gravel or rock outcrop. It carries a large proportion of micaceous and feldspathic material. The type occurs on sloping or rolling plains and dome-like elevations and ridges. It consists mainly of ancient stream borne material deposited in extensive foot slopes and derived from the harder rocks of the Rocky Mountains, with the addition in places of recent stream-borne and wind-drifted material and of residual material from underlying sandstone. It is well drained and free from alkali. It is adapted to fruit and truck crops when not too loose and leachy, but generally lies above the limits of irrigation.

	1	2	3	4	5	6	7
Soil (7)	1	9	16	39	22	6	7
Subsoil (4)	1	7	13	34	22	12	11

	Acres.
Garden City, Kans	10,944
Greeley, Colo	18,688
Lower Arkansas Valley, Colo.	[a] 109,888

[a] Of this, 95,680 acres was mapped as Fresno sand and 14,208 as Maricopa sand.

Colorado sandy loam.—The soil is a reddish or yellowish-brown sandy loam of medium to fine texture and rather compact structure, but friable under cultivation. It is usually from 1 to 3 feet in depth and is underlain by a compact, sticky reddish-brown or yellowish-brown subsoil of adobe structure and of loam or sandy loam texture. The texture and structure of the type is, however, subject to considerable variation, being modified in some areas by wash from adjacent soils. It occurs typically on the slopes of the Great Plains or similar prairie or plateaulike regions. It is frequently marked by gravel-strewn bluff or terrace lines and outcropping ledges of shales, sandstones, or limestones. The soil often carries a small quantity of small gravel. The type comes from ancient foot-slope material derived largely from granitic rocks modified by later stream erosion, alluvial deposition, and by residual and wind-blown material. Usually well drained, free from alkali, easily cultivated, retentive of moisture, and adapted to alfalfa, melons, sugar beets, fruit, and vegetables when favorably situated and capable of irrigation.

	1	2	3	4	5	6	7
Soil (8)	1	8	12	22	24	22	11
Subsoil (7)	1	6	8	18	19	27	21

	Acres.
Russell, Kans.	[a] 24,064
Lower Arkansas Valley, Colo.	[b] 156,096
Wichita, Kans.	[a] 3,136

Colorado fine sandy loam.—This type consists of from 2 to 4 feet of a light to dark brown fine sandy loam of friable structure, underlain by a heavy fine sandy loam or loam frequently carrying a stratum of material of compact structure and slightly heavier texture. This soil occurs as extensive areas covering rough and hilly to gently undulating elevated plains, cut by deep, narrow valleys formed by intermittent streams and frequently marked by local swampy depressions or closed drainage basins. Formed largely by residual material derived from underlying shales, shaly sandstone, and sandstone. The type is sometimes gravelly, generally well drained, and free from alkali, except in local depressions. Under irrigation adapted to grains, alfalfa, potatoes, and sugar beets.

	1	2	3	4	5	6	7
Soil (2)	1	2	2	20	35	29	11

	Acres.
Greeley, Colo.	196,480

[a] Mapped as Sedgwick sandy loam. [b] Mapped as Maricopa sandy loam.

Colorado loam.—A loam of rather fine silty texture and usually reddish-brown color, extending to a depth of 6 feet or more, but frequently marked by a compact adobelike stratum of several inches thickness occurring below the first 6 inches or underlain at the depth of 1 to 2 feet by a tough reddish sandy clay of compact adobe structure. This is underlain by Tertiary deposits or by sedimentary rocks. It is sometimes gravelly, the gravel consisting of angular fragments of sandstone and shale. This type of soil occurs both in small and extensive areas in elevated treeless plains of gently rolling or rather hilly topography. The higher elevations are rounded and often broken by outcropping sedimentary rocks. In more elevated districts the surface is dissected by narrow valleys and deep perpendicular-sided arroyos or marked by local drainage depressions. It is derived from underlying unconsolidated Tertiary deposits or consists of residual material from shales, sandstones, and limestones. It is usually well drained and free from alkali, except in local depressions, and is well adapted to alfalfa, sugar beets, small fruits, and ordinary farm crops.

	1	2	3	4	5	6	7
Soil (6)	0	2	3	9	20	50	15
Subsoil (4)	1	3	4	9	19	50	14

	Acres.
Greeley, Colo	78,784
Wichita, Kans	[a] 47,040

Colorado clay loam.—The soil is a tenacious clay loam of dark reddish-brown color and compact adobelike structure, generally 6 feet or more in depth. The type occurs in depressions and over lower slopes of local closed drainage basins of elevated treeless plains. It consists of finer Tertiary foot-slope deposits, modified by further weathering and alluvial wash or sedimentation. Gypsum frequently occurs as small flakes or granules. The surface is nearly level and unmarked by terrace or bluff lines, gravel, or rock outcrop. The soil is generally poorly drained and charged with alkali.

	1	2	3	4	5	6	7
Soil (1)	0	4	6	12	9	38	31
Subsoil (1)	0	1	1	7	9	53	29

	Acres.
Lower Arkansas Valley, Colo.	[b] 832

[a] Mapped as Sedgwick loam. [b] Mapped as Maricopa clay loam.

Colorado loam adobe.—This is a soil of marked, compact adobe structure, checking into cubical blocks upon exposure, but breaking up into a loam when cultivated in a favorable moisture condition. It grades from a fine sandy loam to a heavy loam in texture, is of a yellowish or reddish-brown to dark-brown or dark-gray color, is usually 6 feet or more in depth, and is underlain by Tertiary foot-slope deposits or by sandstones, limestones, and shales. The type occurs upon hilly to lower gently undulating slopes, in local drainage depressions, and in narrow areas bordering arroyos, and is usually without gravel. It is derived from underlying Tertiary deposits and sedimentary rocks, modified by alluvial washings from higher slopes and by wind-blown material. Gypsum and lime are frequently found in large quantities. The soil is retentive of moisture and is adapted to alfalfa and grains when capable of irrigation. It is not damaged by accumulation of seepage waters or alkali from irrigation of higher lying lands.

	1	2	3	4	5	6	7
Soil (4)	0	1	3	18	23	37	18
Subsoil (4)	0	1	2	19	21	29	27

	Acres.
Greeley, Colo	[a] 5,632
Lower Arkansas Valley, Colo.	[b] 37,284

BILLINGS SERIES.

The soils of the Billings series consist of ancient stream-deposited material, with an admixture of residual and colluvial material derived from shales, sandstones, or adjacent soil bodies. They occur in old, elevated stream terraces, stream flood plains, and in sloping valley plains or as second bottoms of stream valleys carved from the sedimentary rocks of elevated plains and plateaus. The surface is frequently cut by arroyos or intermittent stream channels. The soils often cover extensive areas and are prevailingly of dark or nearly black color, and frequently of compact, sticky, adobelike structure. In depressions or along lower slopes subject to seepage from irrigation from more elevated soil bodies they are frequently poorly drained and filled with alkali. When properly drained and cultivated they are valuable and productive soils.

[a] Mapped as Colorado adobe. [b] Mapped as Maricopa sandy adobe.

Billings gravelly loam.—The soil is a loam from 0 to 18 inches deep and is underlain by a loam or light clay loam 3 feet deep, beneath which is found waterworn gravel. Both the soil and subsoil contain gravel. The type is found in terraces which were formerly river banks and is free from alkali and well drained. Where occurring on plateaus the soil is well adapted to grain and alfalfa.

	1	2	3	4	5	6	7
Soil (2)	1	3	4	12	20	36	26

	Acres.
Billings, Mont	11,776

Billings fine sandy loam.—The soil is a light-gray to brown fine sandy loam, about 1 foot in depth, and is underlain by light-colored fine sandy loam, sands, or gravel, often imperfectly stratified. The soil sometimes extends to a depth of 6 feet or more with but little change in texture or structure. It has a somewhat compact structure, but is friable under cultivation. The type occurs upon gently sloping valley plains in the vicinity of bluff lines or rock outcrop, and is often cut by arroyos or gullies with perpendicular walls. It consists of old alluvial deposits modified by colluvial and alluvial wash from adjacent sandstone and shale material and from more elevated soil bodies. It is generally well drained and free from alkali, and is adapted to alfalfa, sugar beets, fruits, vegetables, and general farm crops.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	21	36	27	16
Subsoil (2)	0	0	1	41	34	13	11

	Acres.
Billings, Mont	[a] 13,568
Grand Junction, Colo	26,944

Billings loam.[b]—The Billings loam varies widely in texture and in character of subsoil, but consists in general of a reddish-brown to dark-gray or nearly black loam, which is underlain by sand or sandy loam or loam of lighter color. Fine gravel frequently occurs in both soil and subsoil. The type usually occurs as rather narrow bodies occupying nearly level valley slopes, and is frequently marked by the presence of stream channels or swampy depressions. It consists of alluvial and colluvial wash from shales, limestones, and more elevated

[a] Mapped as Billings sandy loam. [b] See also Billings clay loam, p. 214.

soil bodies, mingled with older alluvial deposits. Where well drained and free from alkali it is adapted to sugar beets and general farm crops.

	1	2	3	4	5	6	7
Soil (2)	1	2	3	16	20	32	26

	Acres.
Greeley, Colo	41,984

Billings silt loam.—The soil is a light-gray to dark-brown silt loam, generally 3 feet or more in depth, and is underlain by lighter or heavier subsoils, varying from sands to clays, which in turn are sometimes underlain by gravel. The soil is usually of compact adobelike structure, is very sticky when wet, puddles readily, and bakes and checks upon exposure, but is generally friable under proper cultivation. The type occurs as a second bottom soil along lower valley plains and adjacent to recent stream deposits. The surface is level except for minor terrace lines, arroyos, or other old or intermittent stream channels. The lower lying bodies are often poorly drained and contain alkali, but otherwise the soil is well adapted to sugar beets, grains, and alfalfa.

	1	2	3	4	5	6	7
Soil (2)	0	0	0	4	11	57	28

	Acres.
Grand Junction, Colo	5,632
Greeley, Colo	4,032

Billings clay loam.—The soil is a gray to dark-brown or black plastic clay loam from 1 to 6 feet in depth, of heavy compact structure, somewhat given to puddling when wet and baking upon exposure. Where less than 6 feet in depth it is underlain by clay and occasionally in the lower part of the section by coarse sandy loam, loam, or gravel. The subsoil is generally of dark-gray to black color. The type usually occurs upon old stream-formed terraces and low, nearly level valley plains, and is frequently marked by the presence of slough or stream channels, gullies, or swampy depressions. Small gravelly ridges sometimes occur in the vicinity of stream channels. It consists largely of shale and sandstone material and is formed by old stream deposits and by colluvial wash from bluffs and higher lying soil bodies. With the exception of poorly drained and alkali-impregnated depressions and lower slopes the soil is well adapted to alfalfa, grains, and vegetables, and sometimes to fruits.

	1	2	3	4	5	6	7
Soil (4)	0	1	1	9	14	42	33
Subsoil (3)	0	1	1	14	21	36	26

	Acres.
Billings. Mont	[a]14,144
Grand Junction, Colo	3,328
Greeley, Colo	12,800

Billings clay.—The soil is a yellowish-gray to black clay, generally extending to a depth of 6 feet or more, but is sometimes underlain at less than 6 feet by strata of dark-gray to black clay loam or loam, or by sand and gravel. It is generally of compact, refractory, adobelike structure, puddles readily, bakes and checks upon exposure, and is of an impervious nature and very tenacious when wet. The type occurs upon old stream terraces and lower valley plains and in depressions marking swampy areas or former lagoons or slough beds. It has generally a nearly level or only slightly sloping surface, and is unmarked by gravel, except in the vicinity of upland bluff lines, where fragments of shales or sandstone may occur. The soil is usually rich in organic matter and is often poorly drained and alkaline. In origin and mode of formation it is similar to the Billings clay loam. It is generally best adapted to pasturage, hay, grains, and sugar beets.

	1	2	3	4	5	6	7
Soil (5)	0	0	0	5	8	40	47
Subsoil (5)	0	0	1	6	9	41	43

	Acres.		Acres.
Billings, Mont	17,088	Laramie, Wyo	16,064
Grand Junction, Colo	1,664	Lower Arkansas Valley, Colo	[b]4,096

FRUITA SERIES.

The soils of the Fruita series are similar in origin, mode of formation, and topographic features to those of the Billings and the Mesa series. They are usually of a reddish-brown color, somewhat compact structure, though friable under cultivation, and in lower depressions are often poorly drained and filled with alkali.

Fruita fine sandy loam.—The soil is a reddish-brown fine sandy loam, generally 6 feet or more in depth, interstratified with layers of sand and loam. It is of friable, pervious structure, and has a slightly sloping or nearly level, smooth surface, sometimes cut by washes formed

[a] Mapped as Billings loam.

[b] Mapped as San Joaquin black adobe.

by intermittent streams. The type consists mainly of alluvial and colluvial material derived from washing of sandstones and higher lying upland or mesa lands and deposited over intermittent-stream-formed fans. It is subject to considerable damage from alkali and seepage waters, but when well drained and free from alkali is adapted to alfalfa, sugar beets, fruits, and truck crops.

	1	2	3	4	5	6	7
Soil (1)	0	1	2	24	27	35	11

	Acres.
Grand Junction, Colo	3,968

Fruita loam.—This type is similar in color, topographic and drainage features, origin and mode of formation, to the Fruita fine sandy loam. It consists of a sticky loam of compact, adobe structure usually from 1 to 3 feet in depth, resting upon a silt loam subsoil. The soil possesses marked puddling tendencies and bakes upon exposure. The type occurs in local depressions or upon lower slopes and is generally rather poorly drained and filled with alkali. When well drained and free from alkali it is well adapted to alfalfa, grains, and general farm crops.

	1	2	3	4	5	6	7
Soil (2)	0	1	3	17	18	39	22
Subsoil (1)	0	0	0	2	6	65	27

	Acres.
Grand Junction, Colo	512

MESA SERIES.

In origin, mode of formation, and topographic features the soils of the Mesa series are similar to those of the Billings and the Fruita series. They consist of former flood-plain deposits now existing as old elevated river terraces or mesa lands. The surface is often rough and hilly. The soils generally vary from light gray to chocolate-brown in color, are friable to compact in structure, and are underlain by shale and sandstone rock. They are sometimes poorly drained and impregnated with alkali in small local depressions.

Mesa fine sandy loam.—The soil is a reddish to chocolate-brown fine sandy loam, of light friable and often porous and leachy structure, extending to a depth of from 4 to 20 feet or more and underlain by shale and sandstone. The type occurs as elevated level to broken and hilly mesa lands, often marked by gravel-strewn bluff lines. It consists probably of old flood-plain deposits derived from sedimentary, granitic, and volcanic rocks, and modified by subsequent erosion and æolian agencies. The soil, when within the reach of irrigation, is best adapted to fruits and tilled crops.

	1	2	3	4	5	6	7
Soil (1)	0	1	3	18	21	31	25

	Acres.
Grand Junction Colo	34,432

Mesa clay loam.—The soil consists of a stiff, plastic, refractory and compact reddish to chocolate-brown clay loam, usually from 4 to 6 feet in depth and underlain by sandy and gravelly material grading to shale and sandstone. The type occurs in depressions and is probably formed largely of the finer wash from the Mesa fine sandy loam. It is generally free from alkali, productive, and well adapted to alfalfa, sugar beets, and grains.

	1	2	3	4	5	6	7
Soil (1)	1	2	3	12	20	25	37

	Acres.
Grand Junction, Colo	2,240

Mesa clay.—The soil is a sticky clay of rather heavy texture and of compact, refractory structure, puddling and baking upon exposure and difficult to till. It is of light-gray to a dark slaty color, from 1 to 6 feet or more in depth, and is underlain by shale rock. The type occurs upon elevated mesa lands of slightly undulating or nearly level to rough hilly outline, broken by perpendicular cliffs, and is partially residual in origin, being derived from the underlying shale. Local depressions are often unproductive because of the accumulation of seepage waters. Where well drained the soil is adapted to the production of alfalfa and sugar beets.

	1	2	3	4	5	6	7
Soil (1)	0	3	1	4	6	43	43

	Acres.
Grand Junction, Colo	22,464

SAN LUIS SERIES.

The material forming the San Luis series was derived originally from volcanic rocks, principally trachyte, and represents ancient lacustrine sediments or lake beds, more or less modified by subsequent alluvial wash, wind-drifting, and weathering. The soils occupy filled valleys as broad, nearly level, or gently sloping plains, the surface being broken only by small mounds or ridges or by forms produced by wind-drifting. They occur as small irregular to broad, extensive areas, often gravelly, the gravel consisting of medium to fine fragments. The soils are of reddish-brown color, porous structure, and are underlain by sands and coarse, rounded gravel. The lower lying bodies are often subject to injury from seepage and accumulation of alkali from irrigation upon higher adjacent soils.

San Luis sand.—The soil is a coarse to medium incoherent, loose, reddish-brown sand containing a large proportion of fine gravel, and underlain at a depth of from 2 to 4 feet by a coarser material which can not be penetrated with the auger. The soil is composed of minute fragments of volcanic rock, and is light and easily shifted by the wind. In origin it is without doubt a lacustrine deposit and the generally level surface is crossed by minor ridges thought to be the result of varying deposition taking place in currents of different velocities. There are also some dunes from 1 to 6 feet high. These irregularities are a great hindrance to cultivation and irrigation. The drainage is excessive and constant irrigation is necessary. This has swamped some areas, and brought about the rise of alkali over large tracts of the type. Much of the originally productive land has been abandoned for this reason. Fair crops of the small grains are grown. The yield per acre of wheat is 15 to 30 bushels; of oats from 20 to 40. Pease are grown for pasture and for hay.

	1	2	3	4	5	6	7
Soil (4)	10	26	15	19	12	10	8

	Acres.
San Luis Valley, Colo	136,960

San Luis sandy loam.—The soil is a coarse gravelly reddish-brown loam from 18 inches to 3 feet deep, resting on a subsoil of almost pure gravel and sand, which extends to indeterminate depths. Near the mountains the surface soil is shallower, more sticky, and the gravel larger and more waterworn. Heavier phases of the soil are known locally as "adobe." The type occupies imperceptibly sloping plains, the surface of which is broken by many knolls and ridges from 8 inches to not more than 2 feet in height. The soil is a lacustrine deposit. Near the mountains the soil is well drained and free from alkali. The lower areas are filled with alkali. Nearly all the cultivated areas are sown to cereals and pease. It is well adapted to these crops and also to potatoes and truck crops.

	1	2	3	4	5	6	7
Soil (3)	7	19	9	16	16	20	13
Subsoil (1)	2	5	1	6	27	52	6

	Acres.
San Luis Valley, Colo	196,992

San Luis loam.—The soil is a plastic and sticky reddish-brown loam containing some gravel, 24 to 36 inches deep, resting on a subsoil of sand or sandy loam, beneath which occurs sand and gravel. The surface is level and uniform and well adapted to irrigation. The soil is a lacustrine deposit formed by further breaking down of materials of San Luis sandy loam, contains more or less alkali, and is not at present cultivated. When irrigated the soil produces a good crop of wild hay and would be well adapted to the grain crops.

	1	2	3	4	5	6	7
Soil (1)	1	7	7	23	16	12	34

	Acres.
San Luis Valley, Colo	9,088

LAUREL SERIES.

The soils of the Laurel series occupy low, nearly level or slightly sloping stream terraces and river flood plains, or more elevated slopes adjacent to intermittent streams subject to flood. They consist of recent alluvial sediments deposited from the turbid flood waters of wide, shallow, shifting streams traversing elevated valleys, plains, or plateaus. The soils vary in color from light-gray to reddish-brown or black, according to position and the quantity of organic matter present, and are often poorly drained and filled with alkali.

Laurel fine sand.—The soil is a micaceous fine sand of light-gray to reddish-brown color and loose, porous structure. It is from 1 to 6 feet or more in depth and is underlain by coarser river sands and gravels or sometimes by heavier alluvial deposits. The type frequently occurs in long, narrow bodies covering river flood plains and lower stream terraces and is often cut by sloughs, stream channels, or depressions and slight ridges, and is subject to overflow. It consists of recent stream deposits and generally shows considerable variation in texture and structure. It frequently supports a considerable growth of willows and cottonwood. The soil is sometimes used for alfalfa and truck crops.

	1	2	3	4	5	6	7
Soil (1)	0	1	4	64	23	5	3
Subsoil (1)	0	1	5	75	17	1	1

	Acres.
Grand Junction, Colo	3,008
Lower Arkansas Valley, Colo	[a] 5,952
Sarpy County, Nebr	5,440

Laurel sandy loam.—The soil is an alluvial sandy loam or fine sandy loam 2 to 6 feet deep, light-yellow to black in color, and is underlain by waterworn gravel and sand. The surface is usually level and is marked by sloughs, old river channels, and swampy areas due to seepage from irrigating ditches. Except where affected by alkali, the soil is excellent for grain, vegetables, and fruits.

	1	2	3	4	5	6	7
Soil (11)	1	6	7	23	25	25	13
Subsoil (5)	6	18	16	27	14	11	8

	Acres.		Acres.
Billings, Mont	8,832	Greeley, Colo	33,792
Garden City, Kans	16,000	Laramie, Wyo	29,440
Grand Junction, Colo	3,072	San Luis, Colo	[b] 35,776

Laurel fine sandy loam.—The soil is a light-gray to brown fine sandy loam from 0 to 15 inches in depth, resting on a lighter colored material slightly more sandy than the soil. The type occupies low, flat areas bordering streams and is purely alluvial in origin. It is not subject to overflow and in general is well drained. The soil is best adapted to corn and alfalfa, which sometimes suffer from drought, owing to the loose, porous nature of the soil.

	1	2	3	4	5	6	7
Soil (3)	0	1	3	36	32	18	9
Subsoil (3)	0	1	3	30	33	22	10

	Acres.
Russell, Kans	[c] 8,832
Sarpy County, Nebr	5,760

Laurel loam.—The soil is a rather heavy dark-brown or dark-gray loam varying considerably in texture. The color usually becomes lighter as the depth increases. It is usually underlain by waterworn gravel or sand at from 3 to 6 feet and is frequently interstratified with

[a] Mapped as Fresno fine sand.
[b] Mapped as Rio Grande sandy loam.
[c] Mapped as Lincoln sandy loam.

layers of sandy loams and silt loams of yellowish, gray, or mottled colors. The soil is of porous structure, readily permeable to water and sometimes of a leachy character. The type occurs in long, narrow strips covering stream bottoms or lower stream terraces, and when well drained and not subject to destructive overflow is adapted to alfalfa, sugar beets, grains, etc.

	1	2	3	4	5	6	7
Soil (8)	0	2	3	10	22	41	21
Subsoil (6)	1	5	8	21	20	29	15

	Acres.
Garden City, Kans	8,704
Lower Arkansas Valley, Colo.	[a] 37,760
Wichita, Kans	[b] 45,568

Laurel clay loam.—The soil is a sticky, plastic black loam containing considerable gravel, resting on a subsoil of sand and gravel which extends to undetermined depths. The soil contains considerable organic matter and is found along small streams and in depressions. The type is formed partially from materials brought by the streams from the mountains and partially by the further disintegration of the materials forming the adjacent soils. The soil is very difficult to cultivate. When wet it is a sticky mass of mud and when dry it bakes similarly to the adobes of the Pacific coast. It is not esteemed a very desirable soil for grain or alfalfa and at present is used mainly for pasturage. The drainage is rather poor and would be difficult to improve.

	1	2	3	4	5	6	7
Soil (4)	2	5	3	9	14	36	31

	Acres.
San Luis Valley, Colo	[c] 23,104

Laurel loam adobe.—The soil consists of a reddish-brown or chocolate-brown loam of rather heavy texture and usually of compact, refractory, impervious adobe structure, exhibiting pronounced puddling tendencies. It is very sticky when wet and bakes and checks into cubical blocks upon exposure. The soil often contains a noticeable quantity of coarse sand and fine gravel and generally extends to a depth of from 3 to 6 feet or more and is underlain by sandy loam,

[a] Mapped as Santiago silt loam.

[b] Mapped as Arkansas loam.

[c] Mapped as Rio Grande loam.

sand, and gravel. The type occurs upon lower stream terraces, river-bottom lands, and along the trough of small tributary stream valleys. The surface is generally level, frequently marked by willow or other tree growth, and is cut by stream channels. It consists of stream deposits modified by weathering and wash from adjacent heavy soils, and is in places subject to overflow or to injury from the accumulation of alkali or seepage waters. Where well drained and free from alkali it is well adapted to the production of grains, sorghum, alfalfa, or sugar beets.

	1	2	3	4	5	6	7
Soil (1)	3	5	4	11	27	33	17
Subsoil (1)	1	2	2	9	15	45	26

	Acres.
Garden City, Kans	[a] 1,472

MISCELLANEOUS SOILS OF THE ROCKY MOUNTAIN VALLEYS, PLATEAUS, AND PLAINS.

Finney sandy loam.—The soil is a medium to fine sandy loam ranging in depth from a few inches to several feet and is always underlain by a silt loam, sometimes quite heavy and usually extending to a great depth. The type is formed largely of wind-blown sandy material overlying Plains marl. Since the deposition of the sand weathering has produced marked effects on the texture of the soil, which contains a good percentage of clay and silt. It is free from alkali, but the subsoil contains considerable lime. The surface of the type is generally rolling, especially in upland areas. It has good drainage and by reason of the heavy subsoil it has also an excellent moisture-holding capacity. Sorghum and alfalfa are the crops principally grown. Much of this type is used for grazing.

	1	2	3	4	5	6	7
Soil (3)	1	8	11	23	20	25	12
Subsoil (2)	0	1	1	6	19	53	20

	Acres.
Garden City, Kans	6,272

Fort Collins loam.—The soil is a dark-brown or reddish-brown to almost black loam from 4 to 12 inches in depth and is underlain by a layer of heavy loam from 1 to 4 feet in thickness, beneath which the subsoil grades into a light loam similar to the surface soil and extending

[a] Mapped as Colorado adobe.

to a depth of 6 feet or more. The soil becomes very sticky when wet, and bakes badly, often breaking into rough cubical blocks upon exposure after puddling. The surface is generally level, though occasionally slightly rolling or undulating, and sometimes pitted by erosion and cut by small intermittent streams. This is for the most part a residual type formed by the weathering in place of clayey or shaly sandstones and sandy shales. The soil is well adapted to wheat, oats, barley, alfalfa, sugar beets, potatoes, and apples.

	1	2	3	4	5	6	7
Soil	1	2	2	14	29	33	19

	Acres.
Greeley, Colo	14,144

Finney clay.—The soil is a dark tenacious clay from 2 to 6 feet deep, overlying a silt loam or Plains marl of great depth. When dry, large cracks, often 2 inches or more in width, occur in the soil. The type is found mostly in upland prairies, occupying small local depressions known as "buffalo wallows," the soil being formed by the wash from the surrounding higher levels. It has no agricultural value, and the areas are usually covered with a poor quality of swamp grass.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	4	14	41	39
Subsoil (1)	0	1	0	1	14	59	25

	Acres.
Garden City, Kans	2,240

SOILS OF THE ARID SOUTHWEST.

The soils of the arid Southwest are mainly of colluvial, alluvial, and lacustrine origin, modified by the addition of recent stream sediments. They occupy mountain foot slopes, alluvial fans, débris aprons, or sloping plains of filled valleys, sloping or nearly level plains, and bottoms of stream valleys or sinks and drainage basins. The principal colluvial soils of this region are also common to the Pacific coast. The climate of the arid Southwest is characterized by semitropical desert conditions, and where the soils are not capable of irrigation they have little or no present agricultural value.

INDIO SERIES.

The Indio series occurs in desert valleys, covering sloping valley plains, upper valley slopes at the foot of mountain ranges and mountain foot slopes. The soils are derived mainly from granitic rocks, mingled with some shale and sandstone material, and are formed by colluvial and alluvial wash from intermittent or torrential streams, and in certain cases have been deposited in the waters and modified by the shore deposits of ancient lakes or bays. They are generally of light color and porous structure, usually underlain by coarser sands and gravels, and their surface is rough and hilly, scarred by the channels of intermittent streams, or drifted by winds.

Indio gravelly loam.—The soil is a gravelly loam, about 2 feet deep, and is underlain by clay to a depth of 6 feet or more. In some of the areas the interstitial material becomes quite sandy. The gravel consists of agate, quartz, chert, limestone, granite, obsidian, and indurated clay, varying in size from 1 inch to 5 or 6 inches in diameter. The type represents old beach lines or alluvial cones. In the lighter phases the soil contains little alkali, but elsewhere the alkali content is high. The soil is subject in places to destructive erosions by mountain floods, and much of it lies too high or is too rough for cultivation. When irrigable and not too alkaline it is suitable for fruits and vegetables.

	1	2	3	4	5	6	7
Soil (1)	2	8	12	39	13	7	16
Subsoil (1)	1	3	3	12	5	25	51

	Acres.
Imperial, Cal	[a] 43,328

Indio sand.—The soil consists of a medium to rather coarse sand of light-gray color and loose, porous structure, and is composed of slightly rounded quartz particles, mingled with micaceous and granitic material. It is usually 6 feet or more in depth and is underlain by coarser material of the same character. The type occurs upon sloping valley plains and covers extensive areas of the higher slopes skirting the mountains. The higher bodies are formed mainly by wash from the adjacent mountains, distributed over sloping fans and débris aprons by intermittent streams. The lower lying bodies consist of old beach sands mingled with and modified by alluvial and colluvial mountain wash. The more elevated areas are generally gravelly, sometimes strewn with bowlders, and are of rough, broken outline. The soil is well drained and free from alkali, but generally lies above the limits of irrigation, and is therefore of no agricultural value.

	Acres.
Indio, Cal	[b] 50,112

[a] Mapped as Imperial gravelly loam. [b] Mapped as Fresno sand.

Indio fine sand.—The soil is a light-gray micaceous sand, usually of loose, friable structure and of fine sandy texture, but sometimes of a rather heavy, loamy nature. It is from 3 to 6 feet in depth and is underlain by coarse sand. The type occurs upon lower and intermediate uniformly sloping plains formed by erosion from adjacent mountains. The surface is marked by minor scoriations and wind-formed ridges. With the exception of the lower lying bodies it is well drained and free from alkali and is adapted to grains, sweet potatoes, melons, etc.

	1	2	3	4	5	6	7
Soil (5)	0	1	2	19	35	25	18
Subsoil (2)	0	1	1	15	35	33	16

	Acres.
Indio, Cal	[a] 36,032

Indio fine sandy loam.—This is a fine sandy loam subject to considerable variation in texture, of micaceous, porous, friable structure and of slate color. It is from 2½ to 5 feet in depth and is underlain by sandy loam or sand. The type covers extensive areas over lower valley plains. It was probably deposited in the waters of an ancient bay or an arm of the sea, but has subsequently suffered considerable modification through the erosive and distributing forces of winds and intermittent streams, the surface being now rather rough and badly wind drifted. The soil possesses marked capillary powers and the lower lying bodies are often poorly drained and filled with alkali.

	1	2	3	4	5	6	7
Soil (4)	0	1	3	24	40	19	14
Subsoil (4)	0	1	4	24	28	26	16

	Acres.
Indio, Cal	[b] 42,432

GILA SERIES.

The Gila series consists of recent stream deposits derived from a variety of rocks and occurs over river flood plains and lower stream-formed terraces. The soils of this series are generally subject to overflow, and are often eroded or modified by torrential floods, cut by stream channels, more or less wind-drifted, and frequently covered with dense thickets of willows, cottonwoods, mesquite, canaigre, or other small

[a] Mapped as Fresno fine sandy loam.
[b] Mapped as Fresno sandy loam.

timber or bushes. They are of light to dark brown color. The soils of this series are sometimes interstratified with minor layers of heavier sediments and are distinguished from those of the Imperial series by being underlain at varying depths by coarse river sands and gravels.

Gila fine sand.—This is a rather coarse, porous, incoherent fine sand of yellowish to reddish-brown color, generally from 3 to 6 feet or more in depth, underlain by coarser river sands and gravels or bowlders. The type lies along rivers, by which its materials have been transported. The soil has been blown about by the winds and the surface is generally covered with dunes. The characteristic vegetation consists of mesquite, willow, canaigre, yucca, and cottonwood. The soil is often calcareous and frequently contains small quantities of alkali, although not enough to injure plants. It is generally well drained and is adapted to truck, fruit, melons, potatoes, root crops, and sometimes alfalfa.

	1	2	3	4	5	6	7
Soil (5)	0	1	5	48	30	11	4

	Acres.
Pecos Valley, N. Mex	[a] 2,810
Salt River Valley, Ariz	[a] 13,960
Yuma, Ariz	[b] 14,272

Gila fine sandy loam.[c]—The soil is a loose, friable, porous fine sandy loam of light-gray to reddish-brown color, from 3 to 6 feet or more in depth, and is underlain by coarser sands and gravels. Layers of heavier sediments sometimes appear in the subsoil. The type occurs as long and narrow to broader bodies covering lower valley plains and stream bottoms. The surface is frequently wind blown, cut by stream channels, and covered with brush or timber growth. The soil possesses high capillary power, and is usually well drained and free from alkali, except upon lower lying bodies subject to stream overflow or seepage from higher elevations. It is generally adapted to alfalfa, truck, and fruit crops.

	1	2	3	4	5	6	7
Soil (8)	0	0	0	5	32	49	10
Subsoil (3)	0	0	1	23	26	33	17

	Acres.
Salt River Valley, Ariz	18,578
Solomonsville, Ariz	[a] 6,720
Yuma, Ariz.-Cal	[d] 18,496

[a] Mapped as Pecos sand.
[b] Mapped as Imperial sand.
[c] See also Gila loam, p. 227.
[d] Mapped as Imperial sandy loam.

Gila loam.—This is a loam approaching in texture a fine to very fine sandy loam. The soil is from 3 to 20 feet deep, and is nearly always underlain by a coarser sand or by river gravel. In some instances areas of shallow soil have a stratum of heavier material between the surface covering of fine sandy loam and the underlying sand. It is a valley or bottom type occurring usually as long, narrow bodies adjacent to streams. The sandy subsoil insures good drainage where there is an outlet for the ground water. The surface is level or slightly ridged by wind drifting and stream erosion, and the soil is composed of sediments deposited by annual flood waters. Some areas of this soil contain small quantities of alkali. It is a good soil for all crops suitable to the climate, especially for alfalfa.

	1	2	3	4	5	6	7
Soil (4)	0	0	0	5	34	48	12
Subsoil (1)	0	2	2	19	31	33	11

	Acres.
Solomonsville, Ariz	[a] 9,600
Yuma, Ariz	[b] 38,848
Imperial, Cal	[a] 30,784

Gila silt loam.—The soil is a gray to brown silt loam containing considerable clay, from 12 to 30 inches deep, and usually underlain by sand, but in rare instances by loam or clay. It is a valley or bottom type occupying low places such as the beds of former river channels, flood plains, or drainage depressions. The soil is composed of sediments deposited by overflow waters. It is often subject to overflow, and sometimes poorly drained and filled with alkali. It is a rich soil, easily cultivated, and is adapted to a variety of crops suitable to the climate.

	1	2	3	4	5	6	7
Soil (7)	0	0	0	2	8	61	28
Subsoil (2)	0	2	12	55	23	6	2

	Acres.
Yuma, Ariz	[c] 12,672

[a] Mapped as Gila fine sandy loam.

[b] Mapped as Gila fine sandy loam in survey of 1902. Mapped as Imperial fine sandy loam in survey of 1904.

[c] Mapped as Santiago silt loam in survey of 1902. Mapped as Imperial silt loam in survey of 1904.

Gila clay loam.—The soil is a sticky plastic clay loam of chocolate-brown color, containing considerable organic matter. It is from 3 to 6 feet or more in depth, and is generally underlain by sand, but sometimes by minor strata of heavy sediments, which are in turn underlain by sands. It is an extensive type of wide distribution. The surface is generally nearly level and above present stream overflow. The soil is fairly well drained, but is frequently filled with alkali.

	1	2	3	4	5	6	7
Soil (5)	0	0	1	5	14	47	33
Subsoil (2)	0	0	0	1	6	60	33

	Acres.
Yuma, Ariz.-Cal	[a] 24,384

Gila clay. [b]—The soil is a dark-brown to black sticky plastic clay of compact adobelike structure, puddling readily and checking upon exposure. It is from 1 to 3 feet in depth and is underlain by sandy loam, fine sand, or fine sandy loam. The type usually occurs as bodies of level surface, often of small extent, covering flood-plain depressions, slough and lagoon bottoms, and stream beds. It is generally subject to overflow, and frequently poorly drained and filled with alkali. In the Salt River Valley it is probably formed largely from sediments of prehistoric irrigation with muddy water.

	1	2	3	4	5	6	7
Soil (6)	0	1	2	7	21	33	31
Subsoil (4)	0	0	1	29	29	19	18

	Acres.
Salt River Valley, Ariz	13,655
Yuma, Ariz.-Cal	4,096

IMPERIAL SERIES.

The Imperial series consists of old marine or lacustrine sediments more or less covered or modified by subsequent river overflow deposits. The soil types of this series are derived from a variety of rocks and usually occur as extensive bodies covering low, level, or slightly sloping valley floors. Unlike the soils of the Gila series they are underlain to great depths by heavy sediments of close and more or less impervious nature. The surface is sometimes marked by bluff or shore lines, slough or other stream channels, and is usually considerably modified

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[a] Mapped as Imperial loam. [b] Mapped as Salt River adobe.

by wind drifting. The soils are generally of light or reddish color, and in the heavier members are frequently poorly drained and filled with alkali.

Imperial sand.[a]—The soil consists of medium to rather fine sand about 5 feet deep and is generally underlain by loam or clay. The soil is generally well drained and free from harmful quantities of alkali, but the loam or clay subsoil contains alkali in excess, which will rise to the surface should excessive irrigation be practiced. The soil is adapted to any of the crops suited to the climate.

	1	2	3	4	5	6	7
Soil (1)	0	18	22	34	24	0	2
Subsoil (1)	0	0	1	55	32	5	8

	Acres.
Imperial, Cal	1,792

Imperial sandy loam.[b]—The soil is a fine-grained sandy loam 3 feet deep and is underlain by clay or loam. The type has been formed of the coarsest sediments carried by the Colorado River. The surface is irregular and covered with dunes. Where free from excessive alkali the soil is adapted to any crop suited to the southern arid regions.

	1	2	3	4	5	6	7
Soil (4)	0	0	0	12	30	36	22
Subsoil (4)	0	0	0	8	22	45	26

	Acres.
Imperial, Cal	126,656

Imperial clay loam.—The soil consists of a fine-grained sticky clay loam with an average depth of 5 feet, and is underlain by clay or clay loam. The soil is very productive, but frequently contains an excess of alkali salts. Drainage of this soil is costly and difficult on account of its close structure. When free from alkali it is adapted to most of the crops suited to the climate, but as it is likely to pack, annual or cultivated crops will prove most profiable.

	Acres.
Imperial, Cal	[c]341,056

Imperial clay.—This is a heavy clay soil with a depth of 6 feet or more. The surface is usually level, though in places small dunes are seen. It is derived from deposition of the finest river sediment. When

[a] See also Gila fine sand, p. 226.

[b] See also Gila fine sandy loam, p. 226.

[c] Mapped as Imperial loam.

dry and in its natural state, it exists in hard cakes and lumps. In drying after irrigation the soil becomes very hard and cracks intersect the surface in all directions. It is difficult to till and is often filled with alkali and is but little cultivated. It is best adapted to the production of sorghum and millet.

	1	2	3	4	5	6	7
Soil (9)	0	0	0	3	10	35	50
Subsoil (9)	0	0	0	5	5	35	56

	Acres.
Imperial, Cal	33,792
Indio, Cal	13,120

MISCELLANEOUS SOILS OF THE ARID SOUTHWEST.

Pecos conglomerate.—This is a sandy loam to a depth of 2 feet containing a high percentage of rounded gravel, resting upon conglomerate or gravel beds. The type occupies bench lands and bluffs. The soil is derived from disintegration of conglomerate beds, is well drained and free from alkali salts, and readily transmits seepage waters. It is not adapted to agriculture at present.

	1	2	3	4	5	6	7
Soil (2)	0	1	2	13	43	19	18

	Acres.
Pecos Valley, N. Mex	11,680

Yuma sand.—The soil is a rather compact, coarse to medium or fine sand containing sufficient finer material to give it a slightly loamy character. When dry it has the appearance of a sand, but upon irrigation it becomes almost a sandy loam. It is underlain at a depth of from 2 to 6 feet by a succession of layers in which the soil particles are slightly cemented, the binding material being calcium carbonate, nodules of which are also found in the subsoil. The subsoil to a great depth is of the same sandy nature as the surface. This soil is found on mesa lands and is generally level, smooth, and well drained, but where the texture is finer small dunes may be found. Nearly all of this mesa soil contains some alkali, but not usually in harmful quantities. It is adapted to citrus fruits, figs, grapes, garden vegetables, melons, etc.

	1	2	3	4	5	6	7
Soil (3)	1	7	16	55	16	2	3

	Acres.
Yuma area, Ariz	94,400

Pecos sandy loam.—The soil is a fine-grained gray sandy loam 30 inches deep. The subsoil is a gray light loam, slightly heavier than the soil. The type occupies high, level valley land, is derived from lacustrine deposits, and is well drained and generally free from alkali. This is recognized as the best general farming land of the localities in which it occurs.

	1	2	3	4	5	6	7
Soil (7)	0	0	2	11	42	25	18

	Acres.
Pecos Valley, N. Mex	24,770
Roswell, N. Mex	11,540

Roswell fine sandy loam.—The soil is a heavy gray fine sandy loam about 12 inches deep. The subsoil is a light loam underlain by clay at a depth of 5 feet. The type occupies level second-bottom land derived from lacustrine deposits, is poorly drained, and often contains alkali. Where drained and free from alkali it is considered a good farming soil.

	1	2	3	4	5	6	7
Soil (3)	0	0	1	15	32	24	16

	Acres.
Pecos Valley, N. Mex	[a] 9,090

Roswell loam.—The type consists of a loam about 4 feet deep, underlain by a clay loam and clay. It is formed of old lacustrine deposits occurring upon low, level bench land. The soil is naturally poorly drained and contains alkali, but when well drained and free from alkali it is recognized as well adapted to general farm crops.

	Acres.
Pecos Valley, N. Mex	2,730

Glendale clay loam.—The soil is a clay loam 6 feet or more in depth, of fine texture, eroding vertically, and of compact, adobelike structure. The type occupies the level plain forming a low divide between Salt River and Agua Fria River, Arizona, and has been formed by wash from Cave Creek. The soil is generally well drained and free from alkali. It is adapted to grain and alfalfa, and the lighter phases to fruit.

	1	2	3	4	5	6	7
Soil (7)	0	1	2	5	21	42	23
Subsoil (2)	0	2	2	8	34	39	12

	Acres.
Salt River Valley, Ariz	[b] 52,040

[a] Mapped as Roswell sandy loam. [b] Mapped as Glendale loess.

SOILS OF THE PACIFIC COAST.

The soils of the Pacific coast, including those of the coastal and interior mountain ranges, foothills, and valleys, have been classified into a number of series varying in field characteristics, topography, origin and mode of formation, and agricultural importance. They range from residual and colluvial soils of the mountain sides, foot slopes and foothills, to deep and extensive river flood plain and delta sediments. and ancient and modern shore and marine and lacustrine deposits. While some of these series are confined to a single coastal or interior mountain range or valley, others are of wider range and extend over several different physiographic regions. The value of these soils and their adaptation to crops is dependent largely upon the possibilities of irrigation and upon local climatic conditions of rainfall and temperature, all of which are to a great extent dependent upon topography. They range in agricultural importance from those devoted only to extensive grain farming to the most valuable and intensively cultivated lands devoted to citrus and deciduous fruits, vines, small fruits, and other special crops.

SIERRA SERIES.

These are residual soils derived from weathering in place of granitic rocks, diabase, and more or less altered rocks, such as amphibolites, slates, serpentine, and volcanic materials, with a slight admixture of colluvial and alluvial material from the same sources. They are prevailingly of light-red to deep-red color, and generally of somewhat compact structure. They are underlain by parent rocks sometimes separated from the overlying soil by a thin stratum of adobelike material. The soils are frequently very shallow and marked by abundant rock outcrops, bowlders. and rough, rocky areas unsuitable for agriculture. The soils of this series occupy rolling and frequently mountainous districts and foothills, usually support a more or less heavy growth of brush and forest trees, and are generally well drained. This series covers large areas of valuable fruit and grazing lands along the western slope and base of the Sierra Nevada Mountains in California.

Sierra stony loam.—This type is derived from volcanic andesitic breccias and mud flows. The soil is a heavy loam of smooth silty texture and compact structure, frequently gravelly, generally dark in color at the surface, but sometimes grading into light red below. The soil is from 6 to 30 inches deep, and is underlain by volcanic muds and breccias. The type generally occupies flat-topped ridges or elevated, nearly level table-lands. The surface is generally strewn with rounded andesitic cobbles and bowlders. The type sometimes supports a sparse growth of brush or timber, but is usually treeless. It is frequently poorly drained in local depressions. The soil is usually shallow and unproductive, and is used for grazing purposes.

	1	2	3	4	5	6	7
Soil (3)	5	9	5	15	11	32	23
Subsoil (1)	10	30	9	18	4	19	20

	Acres.
Sacramento, Cal	30,080

Sierra sandy loam.—The soil is a coarse sandy loam of granitic origin marked by the presence of a large proportion of light-colored angular rock particles of the size of fine gravel. It is generally plastic when wet and has a somewhat compact structure, but is friable under cultivation. The color of the soil is light red or reddish gray. The soil is generally underlain at a depth of from a few inches to several feet by a thin zone of dark-red adobe similar in texture to the overlying soil and grading into underlying parent granitic rock. The type occupies rolling foothills and sometimes precipitous mountain slopes and is frequently marked by rounded masses of the outcropping rock. The areas of this type are generally well drained, except for occasional small local spots. The type is well adapted to citrus fruits, peaches, cherries, plums, small fruits, and grapes.

	1	2	3	4	5	6	7
Soil (2)	13	24	10	18	7	15	13
Subsoil (2)	12	22	10	16	7	14	19

	Acres.
Sacramento, Cal	64,448

Sierra clay loam.—The soil is a bright to dark red clay loam of fine, smooth, silky texture, sticky and plastic when wet and slightly given to puddling, but is generally friable under cultivation. The soil varies in depth from a few inches to several feet, the average depth being about 36 inches. It is frequently gravelly, the gravel consisting of rather fine flat or angular rock fragments and chips. The type is derived chiefly from the weathering of diabase, limestone, and amphibolites, which underlie the soil. It covers extensive areas of foothill slopes and is frequently precipitous and marked by rock outcrop and mountainous topography. The type is often quite heavily timbered. Drainage is generally good, although in local depressions occurring along ravines the soil is frequently cold and wet. The type is devoted to grazing and growing hay and grains. In favorable locations it is well adapted to peaches, cherries, and other deciduous and small fruits.

	1	2	3	4	5	6	7
Soil (2)	2	6	4	9	8	47	24
Subsoil (2)	3	9	4	10	6	43	25

	Acres.
Sacramento, Cal	128,183

Sierra sandy adobe.—The soil is a red adobe of compact, close structure, tenacious when wet and checking upon exposure. It is subject to much variation in depth and is underlain by disintegrating granite. This type is similar in origin, texture, topography, drainage features, etc., to the Sierra sandy loam. The soil is adapted to dry farming to grain along lower and less pronounced slopes and is excellent for fruits when irrigated.

	1	2	3	4	5	6	7
Soil (11)	3	3	7	25	31	20	9

	Acres.
Fresno Cal	[a]13,376

Sierra loam adobe.—The soil is a dark-red heavy loam of close, compact adobe structure, very sticky when wet, readily puddled, and checking upon exposure. The soil varies in depth from only a few inches to several feet, the adobe structure being more pronounced in the lower depths. The type owes its origin generally to the weathering of gabbro-diorite rock, which underlies the soil and frequently outcrops in angular, rugged ledges over extensive areas. It usually occurs on high, rugged hills and intervening valleys and is frequently covered with a dense growth of brush or small timber. In favorably located areas where the soil is deep it possesses well-developed moisture-retaining properties and is adapted to grains, hay, and grapes with or without irrigation.

	1	2	3	4	5	6	7
Soil (2)	6	14	7	16	11	25	21
Subsoil (2)	6	15	7	15	9	24	24

	Acres.
Sacramento, Cal	[b]10,944

[a] Mapped as Sierra adobe. [b] Mapped as Sierra loam.

MARICOPA SERIES.

The Maricopa series consists of unassorted colluvial and only partially assorted alluvial material formed by soil creep and direct washing from the mountain sides and by the deposits of intermittent, shifting, torrential streams. The soils of this series are derived from a variety of rocks, but generally from those of granitic and volcanic character. They occupy mountain-foot slopes, delta cones or fans, débris aprons, and sloping plains of filled valleys and also occur in stream valleys as the product of a series of minor secondary fans or cones emerging from adjacent more elevated slopes or mesa lands. They are generally treeless and support only a desert vegetation, except when irrigated, are frequently cut by arroyos, and the lighter members are usually gravelly and often strewn with bowlders. These soil bodies vary from small areas of irregular outline to broad, extensive, uniform sheets. The soils are generally of dark color and loose, porous structure. They are generally well drained and free from alkali, and where capable of irrigation are generally well adapted to fruits, vines, and general farm crops.

Maricopa gravelly sand.—This soil consists of a rather light to dark-gray sand of medium to fine texture, usually carrying an appreciable quantity of coarse, sharp particles. It is generally 6 feet or more in depth. In its virgin condition the soil is often of a somewhat compact structure, but under cultivation it becomes of a loose and permeable character and washes readily under irrigation. The soil carries a large quantity of fine or small gravel of angular or subangular outline, usually occurring as fine angular granitic chips. This soil frequently packs firmly in roads and forms a natural macadamized surface. The type is formed largely of unassorted colluvial granitic material distributed by torrential and intermittent mountain streams as broad, gently to abruptly sloping fans and débris aprons. The soil is generally well drained and free from alkali and when favorably situated for irrigation is well adapted to vine, citrus, and deciduous fruits. It is sometimes adapted to the production of vines and grains without irrigation.

	1	2	3	4	5	6	7
Soil (4)	14	14	10	24	17	14	6

	Acres.
Lower Salinas Valley, Cal	[a] 7,600
San Bernardino, Cal	157,056
San Gabriel, Cal	[b] 30,230

[a] Mapped as Soledad gravelly sand.

[b] Mapped as San Gabriel gravelly sand.

Maricopa gravelly loam.[a]—The soil of the Maricopa gravelly loam consists of a light-brown to dark-brown, almost black sandy loam, grading in texture from coarse to rather fine, and is generally 6 feet or more in depth. It is usually of loose, porous, permeable, and somewhat leachy structure, although over limited areas it sometimes assumes a somewhat compact structure in its virgin condition. It carries a considerable quantity of fine, subangular, or waterworn gravel, and when less than 6 feet in depth is underlain by sands and gravel or cobbles, sometimes cemented by lime into a hardpan. The type generally occurs as extensive soil bodies covering mountain foot slopes, rolling foothills, and broad, abrupt to gently sloping débris aprons and fan-shaped plains consisting of colluvial and partially assorted alluvial wash and material distributed by torrential streams. It sometimes occurs as narrow bodies following the courses of minor intermittent streams. The surface is sometimes irregular and is often cut by arroyos and strewn with angular or rounded bowlders. It is derived mainly from rocks of granitic character and is well drained and free from alkali. Owing to its elevated position and its irregularities of surface, it is often incapable of irrigation and is devoted only to grazing or is dry-farmed to grains or vines. In California extensive areas are irrigated and produce heavy yields of grains, grapes, and citrus and stone fruits.

	1	2	3	4	5	6	7
Soil (9)	11	12	9	18	21	18	8

	Acres.		Acres.
Lower Salinas Valley, Cal	[b] 9,570	San Gabriel, Cal	[d] 15,360
Salt River Valley, Ariz	51,066	San Jose, Cal	[b] 7,616
San Bernardino, Cal	[c] 10,304	Ventura, Cal	[d] 4,310

Maricopa sand.[e]—The soil consists of a light-gray to reddish-gray sand of medium texture, usually 6 feet or more in depth, carrying considerable coarse, sharp sandy particles, and sometimes marked in the lower part of the soil section by partially stratified layers of fine sands and loams. The soil is of a loose, porous structure and usually carries more or less rounded or partially rounded gravel, the fragments grading in size from pebbles to cobbles. The type consists of colluvial and

[a] See also Bingham gravelly loam, p. 186; Bridger gravelly loam, p. 196; Maricopa fine sandy loam, p. 238; Maricopa loam, p. 238.

[b] Mapped as Arroyo Seco sandy loam.

[c] Mapped as Maricopa sandy loam.

[d] Mapped as San Gabriel gravelly loam.

[e] See also Colorado sand, p. 209.

partially assorted alluvial material distributed by intermittent streams and occurring as small, narrow bodies extending along the course of arroyos, or as broader sheets covering mountain débris aprons or smaller secondary fans, or as fan-shaped plains bordering bluff lines and mesa lands. The surface is usually gently sloping, but is sometimes broken or hilly, slightly wind-drifted, or traversed by intermittent stream channels or arroyos. The soil is adapted to fruits, vines, and general farm crops when favorably situated for irrigation.

	1	2	3	4	5	6	7
Soil (3)	3	10	15	29	20	18	7
Subsoil (1)	1	7	10	35	19	21	7

	Acres.
Solomonsville, Ariz	17,728
Ventura, Cal	[a] 6,430
Yuma, Ariz.-Cal	[b] 4,160

Maricopa sandy loam. [c]—The soil is a light-gray to reddish-brown sandy loam of medium to rather fine texture, usually 6 feet or more in depth, generally carrying an appreciable quantity of coarse, sharp sand particles, and underlain by compact sandy loam of adobelike structure, or marked in the lower depths by layers of sands, sandy loams, or silt loam. It is sometimes of compact structure, but is loose and friable under cultivation. The type consists of colluvial and partially assorted alluvial material covering mountain foot slopes, sloping plains, débris aprons, and sloping valley plains formed by wash from minor secondary fan deltas. The soil is usually well drained and free from alkali, and under irrigation is generally adapted to fruits and general farm and truck crops.

	1	2	3	4	5	6	7
Soil (6)	6	13	9	21	18	20	13
Subsoil (3)	6	11	7	19	15	27	15

	Acres.
Los Angeles, Cal	13,888
San Bernardino, Cal	[d] 23,424
Solomonsville, Ariz	10,368

[a] Mapped as Fresno sand, gravelly phase.

[b] Mapped as Fresno gravelly sand.

[c] See also Bridger loam, p. 197; Colorado sandy loam, p. 210; Maricopa fine sandy loam, p. 238; Maricopa gravelly loam, p. 236.

[d] Mapped as San Gabriel sandy loam.

Maricopa fine sandy loam.—The soil is a light-brown to dark-brown fine sandy loam, from 3 to 6 feet or more in depth, usually containing considerable waterworn gravel varying in size from small pebbles to cobbles. The soil is generally of loose, porous structure, and is underlain by sands and rounded gravels, sometimes cemented into a calcareous hardpan. The type consists of torrential stream deposits occurring upon mountain foot slopes, mesa lands, and upper valley plains, and is frequently more or less modified by subsequent weathering and the addition of alluvial wash. The soil is well drained, free from alkali, and adapted under irrigation to alfalfa, grains, and citrus, deciduous, and small fruits.

	1	2	3	4	5	6	7
Soil (10)	3	6	8	16	32	20	13
Subsoil (2)	5	11	8	25	20	19	12

	Acres.
Los Angeles, Cal	[a] 5,952
Salt River Valley, Ariz	[b] 106,906

Maricopa loam. [c]—The soil is a chocolate-brown or dark-brown loam generally 6 feet or more in depth, of rather compact structure, sticky when wet, and somewhat given to puddling and baking, and is underlain by heavier loams of compact adobe structure or by gravelly lime hardpan. It usually, but not always, carries considerable rather fine angular or partially worn gravel. The type usually occurs as extensive soil bodies covering mesa lands, the lower margins of colluvial mountain foot slopes, or lower sloping valley plains, over which it has been distributed by intermittent streams traversing secondary fans. The surface of the higher areas is often marked by domelike elevations, bluffs, or terrace lines thickly strewn with cobbles and gravel or deeply cut by torrential stream channels. The lower lying areas are sometimes poorly drained and filled with alkali. Where capable of irrigation the soil is adapted to fruits and general farm crops.

	1	2	3	4	5	6	7
Soil (4)	2	4	5	10	19	27	28
Subsoil (3)	1	3	5	15	24	26	22

	Acres.
Salt River Valley, Ariz	20,650
Solomonsville, Ariz	[a] 12,864

[a] Mapped as Maricopa gravelly loam.

[b] Mapped as Maricopa sandy loam.

[c] See also Fresno loam, p. 256.

Maricopa silt loam.—The soil is a heavy brownish silt loam with a depth of 6 feet or more. The soil has an exceedingly fine texture, crumbling to an impalpable powder when dry, but becoming very sticky when wet. It is easily puddled, bakes upon exposure to the sun, and somewhat resembles an adobe in physical characteristics. It erodes into vertical walls, washes, and gullies. Except as very small particles the occurrence of gravel on the surface is rare. The type occurs in valleys and along streams, and is generally level except where cut by washes. The native vegetation is sparse and often wanting on wind-swept areas. Both surface and subdrainage is apt to be deficient. Some alkali accumulations occur where the soil is irrigated. This soil is best adapted to alfalfa, wheat, barley, sorghum, Egyptian and Indian corn, and sugar beets.

	1	2	3	4	5	6	7
Soil (2)	0	0	0	2	5	68	25
Subsoil (3)	0	0	0	5	14	56	25

	Acres.
Solomonsville, Ariz	11,648

Maricopa clay loam.[a]—The soil is a reddish clay loam 6 feet or more in depth, of dense, impervious structure. The type occurs upon the lower level valley plains, and consists of fine colluvial material modified by subsequent weathering and alluvial wash from higher soil bodies. It is generally adapted to grains, but is rather heavy and compact for alfalfa.

	Acres.
Salt River Valley, Ariz	8,713

PLACENTIA SERIES.

The soils of the Placentia series vary considerably in origin, mode of formation, and topographic position. In general, however, they consist of colluvial waste and of alluvial and colluvial deposits of intermittent or torrential mountain streams, though in some cases they are composed essentially of residual material. In nearly all cases they have been subject to considerable modification subsequent to their formation by weathering and alluvial wash from heavy rains or minor streams. They occur upon undulating hills, mountain foot slopes, mesa lands, and broad, uniformly sloping fan deltas and higher

[a] See also Colorado clay loam, p. 211.

valley plains. They are distinguished from the soils of the Maricopa series, of somewhat similar topographic position and mode of formation, by the prevailing reddish-gray to reddish-brown color and by being underlain by indurated sands, shaly sandstones, disintegrated granite, or more generally by heavy, compact red loams or clay loams of tough, impervious adobe structure. The soils of this series are derived mainly from granitic rocks, shaly sandstones, and sandstones carrying a large amount of granitic material. They are generally well drained, free from alkali, and frequently of somewhat refractory nature. They are tilled with difficulty, but possess marked moisture-retaining properties and include large areas of valuable lands devoted to grains, general farm crops, citrus and deciduous fruits, beans, and other special crops.

Placentia sandy loam.[a]—The soil is a reddish-gray or reddish-brown sandy loam of rather coarse texture and compact structure, containing considerable sharp sand and fine gravel, and is sticky when wet. The soil is generally underlain at from 12 inches to 4 feet by a red sandy loam or heavy loam of rather coarse, sharp texture and compact, adobelike structure, and in the lower part of the soil section it sometimes grades into a sandy loam of looser structure. The type occurs in rolling or hilly to gently sloping or nearly level areas, sometimes only slightly elevated above more recent alluvial deposits. The soil is adapted to alfalfa and fruits under irrigation.

	1	2	3	4	5	6	7
Soil (4)	13	17	9	19	17	16	9
Subsoil (1)	6	11	6	17	23	15	21

	Acres.
Bakersfield, Cal	4,928
San Bernardino, Cal	[b] 61,760

Placentia fine sandy loam.[c]—The soil is a light-yellowish or grayish-brown to reddish-brown, sticky, somewhat plastic loam of fine sandy texture and of rather compact structure, sometimes puddling, baking, and checking slightly, and breaking into clods when dry, but friable under cultivation when in proper moisture condition. It usually carries an appreciable quantity of rather coarse sharp sand and sometimes

[a] See also Placentia fine sandy loam, p. 240, and Placentia loam, p. 241.

[b] Mapped as Placentia coarse sandy loam.

[c] Mapped as Placentia sandy loam.

a small to moderate quantity of rather fine angular or partially rounded gravel. The soil is generally from 15 inches to 3 feet in depth, and is underlain by stiff, tenacious, and relatively impervious sandy or heavier loams, reddish in color and of a compact hardpan or adobelike structure. This subsoil checks cubically upon exposure, is sometimes penetrated with difficulty by tender roots, sometimes has a gray or drab color, and frequently reaches the surface and gives rise to the adobe soils of the Placentia series. Occasionally the soil reaches a depth greater than 3 feet or is underlain by sandy loams or loams of less dense, compact structure. This soil consists mainly of colluvial soil creep and of colluvial and alluvial products of torrential and intermittent streams, and occasionally over small areas of residual material. The type generally occurs as extensive areas covering sandstone and granitic foothills and mountain foot slopes, delta fans, and sloping valley plains. Considerable modification by subsequent weathering, by the addition of alluvial wash, or by æolian agencies has generally taken place. The higher lying bodies are frequently rough, broken by rock outcrop, deeply cut by ravines and arroyos, and lie above the reach of irrigation waters. The soil is productive, easily irrigated, and is devoted to grains, citrus and deciduous fruits, walnuts, grapes, alfalfa, and general farm crops.

	1	2	3	4	5	6	7
Soil (13)	4	8	7	19	19	28	12
Susboil (9)	3	6	6	20	19	30	15

	Acres.		Acres
Lower Salinas Valley, Cal	74,000	San Gabriel, Cal	48,820
Los Angeles, Cal	66,048	San Jose Cal	61,568
San Bernardino, Cal	87,040	Santa Ana, Cal	16,857

Placentia loam.[a]—The soil is a light-brown or reddish-brown loam, usually from 1 to 6 feet or more in depth, sometimes gravelly, and usually of somewhat compact structure. It is underlain by reddish-brown heavy loams of compact, dense, adobelike structure, or in small residual areas by disintegrating rock. The type is similar in topography, origin, mode of formation, and crop adaptation to the Placentia fine sandy loam, but has a somewhat finer and heavier texture.

[a] See also Placentia clay loam, p. 242.

	1	2	3	4	5	6	7
Soil (5)	2	4	5	19	11	40	17
Subsoil (2)	1	6	6	20	17	37	13

	Acres.
Los Angeles, Cal	[a]9,024
Ventura, Cal	[b]23,880

Placentia clay loam.—The soil is a reddish-brown, sticky, plastic clay loam, usually 6 feet or more in depth, of compact structure, puddling readily when wet and baking upon drying. It consists of the finer material washed from higher adjacent soil types and generally occurs in small areas occupying local depressions or lower valley slopes. It is sometimes poorly drained and contains alkali, but is otherwise adapted to the same crops as the Placentia fine sandy loam.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	4	21	44	29

	Acres.
San Bernardino, Cal	[c]2,816

Placentia sandy adobe.—This is a reddish-brown or red, dense, compact adobe soil of tenacious, refractory nature and sandy loam texture, generally carrying a noticeable quantity of rather coarse, angular, sandy or fine gravelly fragments. The soil checks into small cubical blocks upon exposure. It is usually from 3 to 6 feet or more in depth and is underlain by lighter loams or sands of loose, porous structure, or by disintegrating sandstone or shaly sandstone. The soil is sometimes overlain by a few inches of sticky, compact, sandy loam, which grades into the stiff, dense adobe structure of the typical soil. It occurs in small to extensive areas covering rolling foothills, mesa lands, and remnants of elevated sloping valley plains. It sometimes contains a small quantity of alkali. The soil is generally well drained and retentive of moisture, and is dry farmed to grains or irrigated to alfalfa or fruits.

	1	2	3	4	5	6	7
Soil (2)	1	2	3	9	26	38	20
Subsoil (1)	0	1	1	9	18	48	23

	Acres.
Bakersfield, Cal	[d]5,120
Santa Ana, Cal	[e]31,334

[a] Mapped as Los Angeles sandy loam.
[b] Mapped as Placentia sandy loam.
[c] Mapped as Placentia loam.
[d] Mapped as Maricopa sandy adobe.
[e] Mapped as Fullerton sandy adobe.

Placentia loam adobe.[a]—This consists of a dark-brown, compact, plastic, sticky adobe soil of loam texture, possessing the usual adobe structural characteristics, checking upon exposure, and being difficult to cultivate. The soil is from 2 to 6 feet or more in depth and is underlain by light-colored loams of compact adobe structure or by indurated sand or disintegrating granitic material. The type consists mainly of colluvial material modified by recent weathering, erosion, and the addition of fine alluvial material washed from adjacent soils. It occupies rolling hills and sloping plains and is generally devoted to citrus and other fruits, grains, olives, walnuts, etc.

	1	2	3	4	5	6	7
Soil (4)	1	3	2	16	19	31	28
Subsoil (2)	2	5	6	24	21	24	18

	Acres.
Los Angeles, Cal	7,040
San Bernardino, Cal	9,280

Placentia clay loam adobe.—This consists of a reddish-brown or brown compact adobe soil of clay loam texture, generally from 2 to 6 feet or more in depth, underlain by compact, heavy loam, coarse granitic sand, and fine angular gravel or disintegrating sandstone. Below the surface foot of the soil section the color is often of a more pronounced red and the adobe structure more evident. The type consists mainly of colluvial material derived from disintegrating granitic rock and of residual and colluvial material from sandstones, subsequently modified by weathering and by alluvial wash. It usually occurs upon rolling hills and sloping, elevated, and somewhat dissected valley plains, is well drained and free from alkali, and is usually dry farmed to grains or devoted to fruits under irrigation.

	1	2	3	4	5	6	7
Soil (2)	1	2	2	14	12	46	21
Subsoil (2)	2	3	2	11	16	39	28

	Acres.
Los Angeles, Cal	[b] 6,976
Ventura, Cal	[a] 1,940

[a] Mapped as Fullerton sandy adobe. [b] Mapped as Sierra adobe.

OXNARD SERIES.

The soils of the Oxnard series consist of alluvial delta plain deposits, colluvial and alluvial wash from foothills and higher adjacent soil bodies, and occasional small areas of residual material. They are derived mainly from sandstones, shaly sandstones, and shales, and occur upon rolling hills, sloping, elevated, and dissected mesa lands and plains, and lower nearly level valley and delta plains. They usually occupy a less elevated position than the soils of the Maricopa series, are generally derived from less elevated foothills and ranges, and are lacking in the granitic material of the former series. They are generally of dark color and are most frequently underlain by heavier subsoils, which, however, are wanting in the red color and adobe structure of the subsoils of the Placentia series, occupying a similar topographic position.

Oxnard gravelly loam.[a]—The soil consists of a heavy silt loam or a light clay loam of dark-brown, drab, or gray color, generally 6 feet or more in depth, the lower portion of the section usually being of light-gray color. The soil is frequently gravelly and usually carries considerable coarse sandy and fine gravelly particles. It is sometimes of rather compact structure in the virgin condition, but is light and friable under cultivation. The type consists mainly of colluvial and alluvial material deposited over sloping plains by torrential mountain streams and is derived largely from siliceous and bituminous shales, the gravel being made up of light or light-brown chalky or flinty fragments. The soil is very light in weight and is well drained, free from alkali, and is generally devoted to grains and beans.

	1	2	3	4	5	6	7
Soil (3)	1	2	1	7	14	51	20

	Acres.
Lower Salinas Valley, Cal	13,730
Ventura, Cal	2,544

Oxnard sand.—The soil is a yellowish-gray to brownish sand of porous, often incoherent structure, and of medium to fine texture. It is generally 6 feet or more in depth and is underlain by indurated sand, or in low, level delta plains by heavier soils. The type occupies delta plains, mesa lands, and undulating hills. In exposed districts the soil is often wind-blown, and wind-breaks are sometimes necessary to successful cultivation. The soil is well adapted to lima beans and English

[a] Mapped as Salinas shale loam.

walnuts. On areas containing alkali sugar beets are successfully grown, while in southern California grapes and citrus and deciduous fruits are also produced.

	1	2	3	4	5	6	7
Soil (5)	1	9	23	33	16	11	6
Subsoil (2)	1	17	32	24	7	11	8

	Acres.
Los Angeles, Cal	35,840
San Bernardino, Cal	4,480
Ventura, Cal	16,200

Oxnard sandy loam.—The soil consists of a brown to black sandy loam, generally of loose, open structure, but sometimes compact and with a tendency to break up into clods. It is from 4 to 5 feet in depth and is underlain by a heavy sandy loam or a loam. The type is derived mainly from waste from sandstone and shale hills and occupies gently sloping delta plains, elevated plains, and rolling hills, small gravelly areas sometimes occurring in the more elevated locations. The soil in the lower areas is generally rich in organic matter. Where free from alkali it is adapted to lima beans, grains, and sugar beets, and where favorably located it is a good soil for fruits. Where the soil contains alkali it is adapted to sugar beets and barley. It is generally well drained, except in local areas, but frequently contains a harmful quantity of alkali salts.

	1	2	3	4	5	6	7
Soil (10)	0	2	4	19	26	34	10
Subsoil (2)	1	4	6	20	18	25	18

	Acres.
San Bernardino, Cal	22,400
Ventura, Cal	53,200

Oxnard fine sandy loam.—The soil is a greenish-gray, rather sticky, micaceous fine sandy loam 12 to 24 inches in depth, underlain by a rather heavy, sticky gray sandy loam or loam. The sand particles are fine and the sand has a greasy, soft feel. If plowed dry the soil breaks up into large clods, but when moist it is loamy and easily cultivated. The surface is smooth and level. The type is derived from the weathering of an argillaceous, incoherent sandstone. The greater part is well drained, but some portions contain alkali, owing to inadequate drainage. The soil is well adapted to wheat, and with irrigation alfalfa would do well.

	1	2	3	4	5	6	7
Soil (2)	1	6	7	33	19	25	9

	Acres.
San Bernardino, Cal	22,848

Oxnard loam.[a]—The soil consists of a gray or dark-colored sticky loam 3 to 6 feet or more in depth, sometimes of a compact, refractory structure. The type consists of the finer material derived from shales and sandstones and the wash from adjacent higher lying soil types or deposits from stream flood waters, and occupies level flood plains and higher sloping plains adjacent to foothills. The soil is generally well drained, except where subject to overflow. It sometimes contains alkali. It is generally devoted to lima beans and English walnuts.

	1	2	3	4	5	6	7
Soil (3)	0	2	2	23	16	39	16

	Acres.
San Bernardino, Cal	6,912
Ventura, Cal	[b] 12,900

Oxnard silt loam.[c]—The soil is a brown, sticky silt loam, frequently of somewhat compact structure and possessing puddling and baking tendencies, but friable under cultivation. The soil is usually 6 feet or more in depth and is generally derived from the finer sediments of streams draining sandstone areas. It is usually rich in organic matter and occupies nearly level or slightly undulating flood and delta plains. It is sometimes poorly drained and underlain by heavy impervious subsoils. When well drained and favorably situated it is devoted to lima beans, corn, and barley without irrigation, and to lima beans, walnuts, and fruits under irrigation.

	1	2	3	4	5	6	7
Soil (4)	0	0	1	8	11	56	20
Subsoil (4)	0	1	1	11	12	51	20

	Acres.
San Jose, Cal	25,920
Ventura, Cal	5,320

Oxnard clay loam.[d]—This is a rather tenacious clay loam of brown or nearly black color. The soil is generally of a somewhat compact structure, but is usually friable under cultivation, is often gravelly, and is underlain at from 2 to 4 feet by a compact and heavier phase of the same material. The type is derived mainly from sandstone and shale material and occupies stream, flood, and delta plains, or more elevated sloping or undulating colluvial and alluvial plains. It is usually

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[a] See also Oxnard clay loam p. 246 . [c] See also Hanford clay loam, p. 260.
[b] Mapped as Fresno fine sandy loam. [d] Mapped as Oxnard loam.

rich in organic matter, is sometimes poorly drained, and occasionally contains alkali. Under favorable conditions it is well adapted to barley, sugar beets, fruits, small fruits, and vegetables.

	1	2	3	4	5	6	7
Soil (9)	0	2	2	11	15	40	28
Subsoil (7)	1	2	2	10	13	37	34

	Acres.
Los Angeles, Cal	19,520
San Jose, Cal	4,224
Ventura, Cal	6,830

Oxnard clay loam adobe.[a]—This is a heavy, dense, compact black or dark-brown, plastic, adhesive adobe soil of clay loam texture, usually from 3 to 6 feet or more in depth and underlain by heavy loams, sands, and sandy loam, or by decomposing rock. It occurs as alluvial, colluvial, or residual deposits, occupying level or sloping valley plains and rolling foothills. It is derived mainly from shales or crystalline rocks. The soil is difficult to till, but is retentive of moisture and productive. It is usually dry farmed to grains or is devoted to the production of fruits, sugar beets, small fruits, or vegetables under irrigation.

	1	2	3	4	5	6	7
Soil (12)	1	2	2	7	10	37	38
Subsoil (12)	1	1	1	7	11	41	35

	Acres.		Acres.
Los Angeles, Cal	37,440	San Jose, Cal	30,400
Lower Salinas Valley, Cal	11,580	Santa Ana, Cal	16,038
San Bernardino, Cal	11,200	Ventura, Cal	4,290
San Gabriel, Cal	23,650		

SAN JOAQUIN SERIES.

The soils of the San Joaquin series are of prevailingly red color, frequently gravelly, both gravel and soil particles consisting largely of well-worn quartzose material. They are commonly underlain at a depth of 2 or 3 feet by red or reddish-brown indurated clay or sandy layers cemented by iron salts into a firm, impervious, impenetrable hardpan, which may, however, more deeply underlie the soil or may outcrop at the surface. The reddish color of the soils and subsoils and the occurrence of the underlying red hardpan are readily distinguished characteristics marking this series. The soils are generally of compact structure, sticky, and quite readily puddled when wet and frequently separated from the underlying hardpan by subsoils of true adobe structure.

[a] Mapped as San Joaquin black adobe.

They consist of old sediments deposited in the waters and about the shores of ancient lakes or bays of early Pleistocene age, modified by more recent reworking or by alluvial wash from adjacent formations. They occupy valley plains extending from lower rolling foothills down to level valley floors and margins of present stream flood plains. The soils are usually treeless, except in the immediate vicinity of stream channels. The soils generally occur as extensive areas. The natural drainage is usually restricted by topographic position, deficient slope, and the presence of underlying impermeable hardpan, except in case of the lighter deeper members and areas occupying higher well-developed slopes. The soils of this series are generally devoted to dry farming to grains, but the lighter, deeper, and better drained members are sometimes devoted to citrus and stone fruits, grapes, small fruits, and truck crops, and give excellent yields under proper irrigation, drainage, and cultivation. The heavier members are frequently marked by an adobe-like structure. Soils, subsoils, and hardpan are usually free from alkali, frequently marked by the presence of small surface "hog wallow" mounds.

San Joaquin sand.[a]—The soil is a reddish-brown or dark-brown sand of coarse to medium texture, slightly sticky, and of rather compact structure, but loose and friable under cultivation. It is generally underlain at from 18 inches to 6 feet or more by compact, sticky sandy loam or sandy adobe of red color, grading into red sandy or clay iron hardpan. The type generally occurs along treeless ridges and summits of lower foothills or higher undulations of the valley plain. The soil is usually well drained and free from alkali, and in certain sections is well adapted to grapes and citrus and deciduous fruits.

	1	2	3	4	5	6	7
Soil (7)	3	16	23	28	12	9	6
Subsoil (2)	5	33	12	14	6	12	20

	Acres.
Fresno, Cal	43,776
Sacramento, Cal	1,920

San Joaquin sandy loam.—The soil consists of a light-red to dark-red sticky sandy loam of medium texture and compact structure. It is underlain by red hardpan, usually at a depth of about 30 inches, but the hardpan sometimes lies deeper and occasionally outcrops. The hard-

[a] Mapped as Fresno red sand.

pan is frequently separated from the overlying soil by a thin stratum ot adobelike structure. The type covers extensive areas of high, treeless valley plains. It is free from alkali. The higher lying and deeper soil bodies are generally well drained and adapted to grapes and other fruits, and grain. The drainage of the lower lying areas is usually deficient.

	1	2	3	4	5	6	7
Soil (12)	4	9	11	18	22	23	11
Subsoil (3)	1	10	7	19	15	31	20

	Acres.
Fresno, Cal	74,547
Sacramento, Cal	265,216
Stockton, Cal	5,824

San Joaquin fine sandy loam.—The soil is a yellowish-red or red sandy loam of fine, smooth, and somewhat silty texture and compact structure, and is sticky when wet. The soil is subject to considerable variation in depth, but is generally underlain at about 36 inches by a heavy red loam or clay grading to red iron hardpan of a clay or sandy clay texture. The type covers extensive areas on the lower treeless valley slopes. The drainage is usually somewhat restricted. The soil is generally devoted to dry farming to grains, but in favorable locations where the hardpan does not too closely approach the surface it produces valuable crops of table and wine grapes and of bramble and other small fruits.

	1	2	3	4	5	6	7
Soil (2)	1	5	4	26	18	28	17
Subsoil (2)	1	6	5	23	16	29	19

	Acres.
Sacramento, Cal	30,208

San Joaquin loam.[a]—The soil is a red plastic loam of fine silty texture and compact structure, with marked puddling tendencies, extending in depth from only a few inches to 3 feet or more. Below the first foot a heavy adobelike structure usually prevails and merges into the underlying indurated sandy clay iron hardpan. The type covers extensive areas of the lower valley plains and is generally treeless, except in the vicinity of stream channels and flood plains. The drainage is usually poor. Hardpan frequently approaches the surface too closely to allow of profitable crop production. The soil is generally devoted to grazing and dry farming to grains.

[a] See also San Joaquin fine sandy loam, p. 249, and San Joaquin sandy loam, p. 248.

	1	2	3	4	5	6	7
Soil (11)	1	7	6	17	15	36	19
Subsoil (11)	1	8	6	16	17	33	20

	Acres.
Stockton, Cal	5,440

San Joaquin sandy adobe.—The soil is similar in color, texture, depth, topography, drainage, and other general features to the San Joaquin fine sandy loam, but has a dense, compact, adobe structure, puddles readily, and checks upon exposure. It becomes heavier below the first foot, and is underlain by the red hardpan of the San Joaquin series. The soil is generally devoted to grain under a system of dry farming.

	1	2	3	4	5	6	7
Soil (3)	1	5	12	23	22	24	14
Subsoil (1)	0	4	11	19	17	26	19

	Acres.
Fresno, Cal	[a]12,691

San Joaquin clay loam adobe.—The soil is a red adobe with the texture of a heavy loam or clay loam of dense, compact structure, puddling readily, and checking upon exposure. It is generally about 3 feet in depth and is underlain by the dense red hardpan of the San Joaquin series. The soil possesses well-developed moisture-retaining properties. The drainage of the type is restricted. The soil is generally devoted to dry farming to grains.

	1	2	3	4	5	6	7
Soil (11)	1	3	1	5	10	45	35
Subsoil (1)	1	5	4	12	9	35	34

	Acres.
Sacramento, Cal	[a]3,776

STOCKTON SERIES.

The lighter members of this series are a buff to reddish or chocolate-brown color. The heavier members generally exhibit pronounced adobe structure, are usually free from gravel, and are dark-brown to black in color. The soils are underlain by heavy loams or clay loams of lighter color and are frequently separated from the overlying soil by a thin crust or zone of white calcareous clay hardpan free from alkali. They consist in part of alluvium and of wash from more elevated adjacent soils and are generally of older origin than the Hanford series. The

[a] Mapped as San Joaquin red adobe.

heavier members have probably been greatly modified by weathering and by the incorporation and decomposition of organic matter resulting from swamp or marsh conditions. This series occupies extensive areas of the lower, nearly level valley plains traversed by minor foothill streams. The soils are treeless, or are marked by occasional groves of valley oaks. The drainage is usually restricted. The heavier members are generally tilled with difficulty, owing to their heavy texture and structure, and are generally devoted to grains and hay.

Stockton fine sandy loam.—The soil consists of a reddish-brown micaceous fine sandy loam, generally 6 feet or more in depth, of friable and porous structure, and sometimes gravelly. The type is derived from rather recent alluvial material deposited from foothill streams and occurs as small bodies about minor stream sinks or flood plains or gently sloping valley plains. Its drainage is fairly good. It is an excellent soil for fruits and general crops.

	1	2	3	4	5	6	7
Soil (6)	1	4	12	23	25	23	11

	Acres.
Fresno, Cal	[a] 12,832

Stockton loam.—Typically the soil is a light chocolate-brown to dark colored loam, generally free from gravel, 6 feet or more in depth, the lower portion of the section grading somewhat lighter in color and texture. The soil has a fine silty texture, and is frequently of a compact, adobelike structure. The type consists of a mixture of recent and older alluvial material deposited from streams in flood, and occupies level or only slightly sloping valley plains. The areas are either treeless or else support an occasional grove and scattered specimens of valley oaks. The drainage is fair and the soil is productive and usually devoted to grains, hay, and general farm crops.

	1	2	3	4	5	6	7
Soil (1)	1	5	8	25	19	22	20
Subsoil (1)	0	7	13	31	17	19	13

	Acres.
Stockton, Cal	26,176

Stockton silt loam.—The soil is a light-brown silt loam of fine, smooth, micaceous texture, generally 6 feet or more in depth. The structure is frequently rather compact, but the soil is friable under cultivation.

[a] Mapped as Fancher sandy loam.

The type is derived from rather recent stream-borne sediments. It occupies nearly level valley plains and slopes, frequently in the vicinity of minor streams, and sometimes supports a light timber growth. The soil is generally underlain at a depth greater than 6 feet by light-colored calcareous clay hardpan and heavy sediments. The drainage is fair, except in a few small lower lying areas. This is an excellent soil for fruits, vines, grains, and general farming.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	5	19	52	21
Subsoil (1)	0	1	1	5	20	53	21

	Acres.
Stockton, Cal	16,512

Stockton loam adobe.—The soil is usually black in color, but is frequently marked by the presence of small grayish-colored spots. It is generally about 30 inches in depth, and not infrequently contains small angular rock fragments and coarse sand of light color. The soil is underlain by a silty clay loam of light-yellow or buff color. The soil is of a very dense, refractory structure, puddling readily and checking upon exposure, and exceedingly sticky and of waxlike consistency when wet. The type is derived from old stream alluvium modified by the incorporation of large quantities of organic matter and by alluvial wash from adjoining soil areas. It occupies the lower, level valley plains, and is sometimes partially timbered. The drainage of the soil is generally deficient. However, it produces fair yields of general farm crops under careful and timely cultivation.

	1	2	3	4	5	6	7
Soil (1)	0	3	3	15	22	31	26
Subsoil (1)	1	3	3	15	21	43	15

	Acres.
Stockton, Cal	2,560

Stockton clay loam adobe.—The soil is a black heavy clay loam of fine silty texture and of exceedingly stiff, dense, adobe structure. It is usually about 3 feet in depth, and is underlain by a light-brown or yellowish silty clay loam frequently separated from the overlying soil by a thin layer of white calcareous clay hardpan free from alkali. The soil puddles readily and bakes and checks upon exposure when not properly cultivated. It is exceedingly sticky and of a stiff, waxy consistency when wet. The soil contains a large quantity of organic matter and under proper cultivation is capable of absorbing and retaining a large supply of moisture throughout long periods of drought. The type is composed of old alluvium sediments modified by weathering and the addition of organic matter. It occupies extensive areas of the lower valley plains, and is either treeless or else supports occasional groves of valley oak and light timber. The surface is nearly level and is generally marked by arrested drainage. The soil is moderately friable and produces excellent yields of grains, hay, and general farm crops under careful and proper cultivation.

	1	2	3	4	5	6	7
Soil (2)	1	2	4	8	16	42	18
Subsoil (1)	2	3	1	8	8	60	23

	Acres.
Fresno, Cal	[a]5,664
Hanford, Cal	[a]5,470
Stockton, Cal	53,312

Stockton clay adobe.—The soil consists of a chocolate-brown or nearly black heavy clay loam or clay adobe similar to the Stockton clay loam adobe in depth, character of underlying material, structure, drainage, and general physical and agricultural features. It differs from the Stockton clay loam adobe in its somewhat lighter color and lower organic matter content, and is also frequently less friable and productive under cultivation.

	1	2	3	4	5	6	7
Soil (1)	0	2	2	8	12	36	40
Subsoil (2)	1	3	3	9	11	34	39

	Acres.
Stockton, Cal	40,832

FRESNO SERIES.

The soils of the Fresno series are characterized by prevailing light-gray colors, but are sometimes light brown or reddish brown. They are generally underlain by subsoils of fine ashy texture, light color, and compact, close structure, usually separated from the overlying soil by an alkali carbonate hardpan of white or light-gray color. The hardpan softens slowly upon the application of irrigation water, but is normally impenetrable to the roots of growing plants. The series is composed of old delta deposits formed by shifting streams and mountain torrents and occurring as broad, low alluvial delta cones occupying

[a] Mapped as San Joaquin black adobe.

gently sloping plains or slightly rolling valley slopes, generally treeless, and lying above present stream flood plains. The soil material of this series is mainly of granitic origin, although in part derived from volcanic and sedimentary rocks. The lighter members occupying higher positions are generally well drained. The lower lying areas are frequently poorly drained, subject to the influence of seepage water from irrigation, and contain alkali. The soil is adapted to alfalfa, vines, and fruits under proper irrigation, cultivation, and drainage.

Fresno sand.[a]—The soil is a medium to coarse micaceous sand of light-gray or light-brown color and porous, loose, incoherent structure. The soil is usually 6 feet or more in depth and is generally underlain by loams or sandy loams of light color. The type is composed of old alluvial sediments, usually covering extensive areas. It occupies the higher treeless valley plains, with a nearly level or slightly rolling surface. The soil is generally well drained, free from alkali, and usually without gravel. It is adapted to alfalfa, truck, and stone fruits under irrigation.

	1	2	3	4	5	6	7
Soil (8)	2	19	21	24	19	12	3
Subsoil (3)	4	28	17	24	13	9	3

	Acres.
Fresno, Cal	163,200
Hanford, Cal	20,790
Stockton, Cal	9,536

Fresno fine sand.[b]—The soil is a gray, buff, or light-brown micaceous fine sand of smooth texture, slightly sticky when wet, and generally of loose porous structure. The soil is generally 6 feet or more in depth, but is sometimes less, and is underlain by light-gray loams or sandy loams of fine ashy texture, frequently carrying alkali carbonate concretions or hardpan. The surface is smooth or slightly broken and uneven. The type covers broad, extensive areas or occurs as long, narrow bodies. Drainage is generally good. The soil is well adapted to alfalfa, truck, and fruits under irrigation.

	1	2	3	4	5	6	7
Soil (1)	1	6	9	35	28	16	6
Subsoil (1)	1	6	9	35	29	16	5

	Acres.
Stockton, Cal	8,128

[a] See also Colorado sand, p. 209; Hanford sand, p. 257; Indio sand, p. 224; Jordan sand, p. 190; Maricopa sand, p. 236.

[b] See also Hanford fine sand, p. 258; Hanford fine sandy loam, p. 259; Laurel fine sand, p. 219.

Fresno sandy loam.[a]—The soil consists of a light-brown or gray sandy loam containing considerable coarse sand. The soil is generally from 3 to 6 feet deep, but the depth of soil is subject to considerable variation. It is of rather compact structure, is sticky when wet, and has marked puddling tendencies, but is friable if cultivated when in proper condition. The soil is underlain by fine sandy or silty loam of ashy texture, gray color, and compact structure, grading to white alkali carbonate hardpan. The type usually occurs in extensive areas with nearly level or slightly sloping surface, and is locally known as "white ash" land. The lower lying bodies are frequently poorly drained. It is subject to influences of seepage waters from over irrigation and is strongly impregnated with alkali. It is an excellent soil for alfalfa, vines, and fruits when well drained and irrigated.

	1	2	3	4	5	6	7
Soil (1)	3	13	7	17	17	31	12
Subsoil (1)	3	12	6	16	16	33	14

	Acres.
Stockton, Cal	5,952

Fresno fine sandy loam.[b]—This is a light-gray fine sandy loam of ashy texture and compact structure, sticky when wet and readily puddled. The soil is generally 6 feet or more in depth, with the lower portion of the soil section frequently of a somewhat lighter texture. It is generally marked at a depth of from 2 to 4 feet by a stratum of heavy, dense, white calcareous hardpan containing alkali carbonates and by concretions of the same material. The type usually occurs as irregular bodies near the margin of valley plains. The surface is nearly level and slightly depressed. The soil is usually poorly drained and contains alkali. When well drained and properly irrigated and cultivated, it is adapted to fruits and alfalfa where the underlying hardpan does not too closely approach the surface.

[a] See also Fresno fine sandy loam, p. 255, and Indio fine sand, p. 225.

[b] See also Hanford fine sandy loam, p. 259; Hanford silt loam, p. 259; Indio fine sandy loam, p. 225; Marshall silt loam, p. 144; Oxnard loam, p. 246; Weber fine sandy loam, p. 195.

	1	2	3	4	5	6	7
Soil (8)	0	2	7	27	28	26	8
Subsoil (8)	1	2	6	24	30	28	9

	Acres.
Fresno, Cal	[a] 69,811
Hanford, Cal	[a] 10,860
Stockton, Cal	10,304

Fresno loam.—The soil is a gray or reddish-brown compact, sticky, heavy loam of very fine, smooth texture, generally about 3 or 3½ feet in depth. The lower portion of the soil section is marked by concretions and dense, impenetrable hardpan strata of calcareous, alkali-carbonate nature, underlain by loam of fine ashy texture and light-gray color. The type occupies lower valley plains and slight depressions of smooth, level surface. It is frequently strongly charged with alkali and is poorly drained.

	1	2	3	4	5	6	7
Soil (1)	0	3	3	10	23	35	26
Subsoil (1)	5	7	5	10	15	33	23

	Acres.
Bakersfield, Cal	[b] 5,824

HANFORD SERIES.

The soils of the Hanford series consist of recent alluvial materials derived from a great variety of rocks and deposited as river and delta plains. The lighter members sometimes consist largely of mining débris and overlie Pleistocene sediments and hardpan. They are generally light-gray to buff in color, but become dark drab, brown, or nearly black in the case of some of the heavier members occupying low-lying positions. All the members of the series are subject to much variation in depth, color, and character of underlying material. The surface is generally level, slightly sloping or sometimes uneven, and is frequently marked by sloughs or the interlacing channels of streams, many of which carry water only in times of flood and disappear in sandy washes. The heavier members are frequently marked by an adobe structure and the soils are generally free from gravel or bowlders. The soil bodies frequently occur as small, irregular, broad and extensive or long narrow areas extending in the direction of drainage, and are frequently elevated above or depressed below the surface of adjacent soil types. The lighter members and higher-

[a] Mapped as Fresno sandy loam. [b] Mapped as Maricopa loam.

lying soil bodies are usually well drained and are not subject to the influence of seepage waters caused by irrigation, while natural drainage is sometimes deficient in the case of lower lying areas occupying present stream flood or overflowed delta plains, where protection by levees becomes necessary. While similar to the soils of the Fresno series in origin and mode of formation, they generally occupy a lower topographic position, are of more recent origin, are frequently subject to overflow, and, unlike the former, often support a growth of swamp vegetation, brush and willow thickets, and timber in the river bottoms and lower valley plains. The heavier members are also usually of darker color, while the underlying white hardpan and subsoils of ashy texture common in the Fresno series are wanting here. The soils are usually productive and are especially adapted to fruits, vines, vegetables, and truck crops when well drained, free from alkali, and irrigated.

Hanford gravel.—This type consists of gravels, cobbles, and small bowlders mixed with river sands, underlain by river sands or earlier Pleistocene sediments and frequently greatly disturbed and modified by mining operations. It is composed of recent stream wash, is subject to overflow, and has but little agricultural value except for the scant pasture it affords.

	Acres.
Sacramento, Cal.	[a]4,544

Hanford sand.[b]—The soil is a light-gray or brown, micaceous, loose, porous, incoherent sand of medium fine to coarse texture, generally 6 feet or more in depth, underlain by stratified alternating stream deposits. The type is composed of recent stream sediments and generally occurs as irregular or elongated bodies, frequently slightly elevated or depressed, marking former stream channels, or as broad, extensive bodies covering lower stream terraces and delta plains. The surface soil is sometimes more or less drifted by winds. It is generally free from gravel and is usually well drained, except where subject to overflow from adjacent streams. It is a fair fruit and truck soil when well irrigated, but is frequently of a leachy character and deficient in organic matter.

[a] Mapped as Fresno gravel.

[b] See also Fresno sand, p. 254.

	1	2	3	4	5	6	7
Soil (14)	4	12	15	39	18	8	3
Subsoil (4)	4	16	19	29	12	13	7

	Acres.		Acres.
Bakersfield, Cal.	[a] 43,264	San Bernardino, Cal.	[a] 15,296
Los Angeles, Cal.	[a] 58,112	San Gabriel, Cal.	[a] 15,[illegible]90
Lower Salinas Valley, Cal.	[b] 25,030	Santa Ana, Cal.	[b] 66,380
Sacramento Cal.	[a] 1,408		

Hanford fine sand.—Soil is a light-buff, yellowish, or light-brown micaceous fine sand, usually 6 feet or more in depth, but sometimes less. It is generally underlain by sand, fine sandy loam, or loam. The soil is usually free from gravel or other coarse material, has a loose, porous structure, and often has a peculiar smooth, greasy feel imparted by the high content of mica. The type consists of recent river deposits covering low delta plains or occurring as irregular, elongated, and sometimes slightly elevated ridges near former or present stream channels. The low-lying areas are sometimes poorly drained and marked by willow and timber growth in the vicinity of streams. The higher areas are usually well drained and generally require irrigation. It is a valuable soil for alfalfa, potatoes, root crops, and fruits under proper irrigation, cultivation, and drainage.

	1	2	3	4	5	6	7
Soil (9)	1	5	7	34	27	20	5
Subsoil (8)	1	6	6	32	24	23	7

	Acres.		Acres.
Bakersfield, Cal.	[c] 33,920	Los Angeles, Cal.	[c] 16,128
Hanford, Cal.	51,250	Lower Salinas Valley, Cal.	17,040

Hanford sandy loam.—The soil is a grayish micaceous sandy loam of medium to rather fine texture, usually 6 feet or more in depth. It possesses slight puddling and clodding tendencies, but is friable and easily cultivated when moist. The type consists of a mixture of the coarser sandy materials of the Hanford sand with finer alluvium and occurs as irregular bodies or narrow strips. It is sometimes slightly impregnated with alkali and injured by seepage or overirrigation, but is in general a valuable soil for the production of grapes, pears, prunes, etc.

[a] Mapped as Fresno sand. A colluvial phase should have been mapped as Placentia sand.

[b] Mapped as Fresno sand, but includes upland terraces and foothill colluvial and residual phases, which should have been mapped as separate soil types.

[c] Mapped as Fresno fine sand.

	1	2	3	4	5	6	7
Soil (2)	2	12	8	22	23	20	9
Subsoil (3)	1	12	13	25	21	19	6

	Acres.
Hanford Cal	[a]19,860

Hanford fine sandy loam.—The soil is a light-gray, light-brown, or buff to dark drab micaceous fine sandy loam, 3 to 6 feet or more in depth, with a porous to moderately compact structure, but friable under cultivation. The underlying material grades from loose sands to heavy loams. The type is composed of recent deposits occurring along river flood and delta plains. The surface is generally low, level, and frequently timbered or covered with willows and brush. In the vicinity of lower depressions and flood plains of larger streams it is sometimes deficiently drained or subject to overflow when not protected by levees. The soil is generally productive under cultivation when well drained and free from alkali. When favorably situated, it is adapted to alfalfa, general farm crops, fruits, English walnuts, small fruits, asparagus, celery, and truck crops.

	1	2	3	4	5	6	7
Soil (15)	1	2	3	19	27	36	10
Subsoil (11)	1	3	4	19	26	36	9

	Acres.		Acres.
Bakersfield, Cal	[b]23,744	Sacramento, Cal	[c]6,656
Hanford, Cal	30,010	San Bernardino, Cal	[b]11,456
Lower Salinas Valley, Cal	[b]18,330	San Gabriel, Cal	[b]10,790
Los Angeles, Cal	[b]38,656	Santa Ana, Cal	[b]11,552

Hanford silt loam.—The soil is a brown, gray, or buff fine, smooth silt loam, often micaceous, free from gravel, and underlain by dark-colored silty clay loam or by light river sands. It is sticky when wet and has a compact structure, but is friable and easily cultivated when in proper moisture condition. The soil is sometimes puddled by improper cultivation. The type consists of recent or present sediments occurring along river flood and delta plains, is frequently subject to overflow, and is sometimes poorly drained and filled with alkali. It frequently supports a dense growth of willows or small timber. It is an excellent soil for fruits, potatoes, beans, sugar beets, asparagus, hops, alfalfa, and general farm crops when protected from overflow and drained.

[a] Mapped as Fancher sandy loam.

[b] Mapped as Fresno fine sandy loam.

[c] Mapped as Fresno fine sand.

	1	2	3	4	5	6	7
Soil (10)	0	1	1	7	15	56	18
Subsoil (8)	0	2	4	14	18	46	16

	Acres.		Acres.
Los Angeles, Cal	[a] 39,360	San Jose, Cal	[c] 5,184
Sacramento, Cal	[b] 9,024	Santa Ana, Cal	[a] 14,349
San Gabriel, Cal	[a] 5,220		

Hanford clay loam.—This is a clay loam of very fine, smooth texture and moderately porous structure, buff or gray to dark brown in color, containing considerable micaceous material and generally 2 to 6 feet in depth. It is underlain usually by fine sand or fine sandy loam or is streaked with micaceous stream-deposited sediments of fine texture. The soil is usually friable, but is very sticky when wet and has marked puddling tendencies. The type is composed of recent stream sediments and covers low, level areas over stream flood and delta plains. The soil sometimes contains alkali and is poorly drained. It is usually free from gravel and is rich in organic matter. It is productive under proper cultivation, irrigation, and drainage.

	1	2	3	4	5	6	7
Soil (4)	0	1	1	9	16	47	24
Subsoil (4)	1	2	1	11	18	47	20

	Acres.
Bakersfield, Cal	[d] 1,664
Lower Salinas Valley, Cal	[a] 14,120
San Bernardino, Cal	[a] 2,112

Hanford clay adobe.—The soil is a gray to black clay adobe, usually without gravel or coarse material, generally about 3 feet in depth, and underlain by heavy loam or clay loam of lighter color. It sometimes occurs as a thin mantle overlying adjacent soil bodies. The soil has a heavy, refractory, compact structure, puddling readily and checking upon exposure. This is an alluvial type modified by subsequent weathering, and occurs along river flood plains and minor stream sinks. The surface is generally level and is frequently slightly depressed. The type is treeless, or else covered with an occasional growth of willows or oaks. The soil is poorly drained, and is generally subject to overflow. It is generally devoted to grain production and grazing.

[a] Mapped as Santiago silt loam.
[b] Mapped as Sacramento silt loam.
[c] Mapped as Fresno fine sandy loam.
[d] Mapped as Oxnard silt loam.

	1	2	3	4	5	6	7
Soil (2)	1	2	3	9	8	42	35
Subsoil (2)	0	3	2	7	8	35	45

	Acres.
Sacramento, Cal	[a] 12,672

SALEM SERIES.

The Salem series occurs upon rolling hills as residual soils, upon sloping plains as alluvial and colluvial soils, and upon level valley plains and stream bottoms as recent alluvial deposits. The soils of this series are derived from sandstones, crystalline and schistose rocks, and a dense, highly ferruginous basalt. They are from red to dark brown or black in color, and are generally devoted to grains, fruits, truck crops, and hops.

Salem gravelly loam.—The soil is a brown or black loam containing a large quantity of gravel, varying in size from fine gravel to pebbles 2 or 3 inches in diameter. The soil varies in depth from a few inches to several feet, and grades imperceptibly into a subsoil of the same material, but containing more gravel, the whole resting on a bed of waterworn gravel. It is a bottom-land soil derived as a stream wash from the same material as the Salem clay. It is generally well drained, but occasionally the drainage is poor. The soil usually supports a growth of brush, scrub oaks, etc. Where not too gravelly it is fairly well adapted to grain and fruit.

	Acres.
Salem, Oreg	13,120

Salem fine sandy loam.—This is a brown sandy loam of fine texture about 12 inches deep, underlain to 3 feet by a coarse sandy loam grading into sand and gravel. The soil generally contains considerable organic matter. It is a bottom-land soil intersected by stream channels and subject to frequent overflow. It is well drained when not overflowed by streams in flood. It is an excellent truck soil and gives large yields of hops, but the hops grown on this soil are more subject to disease than upon higher lying types.

[a] Mapped as Salinas gray adobe, but includes a residual foothill phase which should have been mapped as a distinct type.

	1	2	3	4	5	6	7
Soil (1)	0	0	1	44	28	15	11
Subsoil (1)	0	1	4	47	19	16	13

	Acres.
Salem, Oreg.	[a]3,648

Salem silt loam.—The soil is a brown to black silt loam 18 to 24 inches deep, which contains considerable organic matter, and is usually quite silty. The subsoil is a yellowish or red clay loam, often mottled with gray and yellow, becoming heavier with depth. The type occupies gently rolling or level valley land and is derived from transported sandstone material, with the addition of some material derived from basaltic and schistose rocks. Drainage is generally good, except in a few local depressions. The soil is well adapted to general crops, as well as to hops and small fruits. Wheat produces from 25 to 30 bushels, oats from 35 to 50 bushels, and hops about 1,500 pounds per acre.

	1	2	3	4	5	6	7
Soil (2)	0	1	1	2	9	62	25
Subsoil (2)	0	1	1	1	8	65	24

	Acres.
Salem, Oreg.	[b]78,656

Salem clay.—The soil consists of a heavy red clay loam or clay 12 to 15 inches deep, resting upon a red clay which is underlain by partly decomposed rocks. The type is derived from red sandstone, argillaceous and schistose rocks, and a dense, close-grained ferrous basalt, all highly ferruginous. It is mainly residual, and is frequently marked by rock outcrop. It occupies rolling and dissected hills, is generally well drained, and in its virgin condition usually supports a considerable growth of timber. The soil is productive and is adapted to wheat, oats, hops, apples, prunes, and peaches. The grain is of fine quality. Wheat yields from 25 to 30 bushels and oats from 30 to 60 bushels per acre. Hops yield about 1,200 pounds per acre. The hops are less subject to mold and insect pests than those grown on the bottom soils.

	1	2	3	4	5	6	7
Soil (1)	2	5	3	8	10	26	45
Subsoil (1)	2	4	3	8	9	24	49

	Acres.
Salem, Oreg.	86,400

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[a] Mapped as Salem sandy loam.

[b] Mapped as Salem loam.

MISCELLANEOUS SOILS OF THE PACIFIC COAST.

Sheridan sandy loam.—The soil consists of a black friable sandy loam of medium texture, varying considerably in depth, the average depth being about 3 feet, and underlain by granitoid rocks. The type usually occupies the lower valley slopes along foothills and extends into local drainage depressions. The soil is of residual or colluvial origin, resulting from the weathering of dark-colored, fine-textured phases of gabbrodiorite and granodiorite rock. A characteristic feature of this rock is the large proportion of black hornblende and biotite mica which it bears, the plates and particles of which give rise to the black color of the soil. In the low-lying areas the material washed from the slopes has been subsequently modified by alluvial material. When adequately drained this soil is adapted to grains, hay, forage crops, and fruit.

	1	2	3	4	5	6	7
Soil (2)	3	11	9	30	19	17	11
Subsoil (1)	4	18	10	28	13	15	12

	Acres.
Sacramento, Cal	1,792

Puget fine sandy loam.—The surface soil consists of 12 inches of drab fine sandy to silty loam, and generally rich in organic matter. This rests upon a subsoil of gray or yellow sand extending to a depth of 36 inches or more. The topography is low and flat, as the type occupies depressed areas along streams. The drainage is poorly established and must be improved by artificial means before cultivation is practicable. It is an intermediate type between the Puget silt loam and the Snohomish sand. The type is mostly devoted to pasturage, though on well-drained areas oats and grasses yield well. Truck crops would probably do equally well upon reclaimed areas.

	1	2	3	4	5	6	7
Soil (2)	0	3	2	20	16	37	21
Subsoil (2)	2	19	16	33	13	11	6

	Acres.
Everett, Wash	4,928

Santiago fine sandy loam.—The soil is a fine sandy loam 3 feet deep, underlain to a depth of 5½ feet by sand, which is in turn underlain by sand and gravel. In the more elevated areas the soil is underlain by sandy adobe. Over a considerable area the gravel comes to the surface and increases in size and quantity in the lower depths. The type occupies lower delta plains of the foothill streams and foothill slopes. The soil is dry-farmed to wheat and barley, and under irrigation is adapted to truck crops and fruits.

	1	2	3	4	5	6	7
Subsoil (1)	2	5	5	26	27	27	7

	Acres.
Santa Ana, Cal	[a] 17,100

Santiago loam.—The soil is a red loam, 3 feet deep, underlain to a depth of 4 feet by a sandy loam, which in turn is underlain by a gravelly sandy loam. It is a harsh, compact soil washed from foothills by streams, and occurs along the margins of the coastal plain near the foothills in southern California. The soil is considered unproductive and is at present little used for agricultural purposes.

	1	2	3	4	5	6	7
Soil (1)	0	3	2	9	25	43	16
Subsoil (1)	0	3	1	6	24	42	21

	Acres.
Santa Ana, Cal	1,830

Puget silt loam.—The soil consists of a drab-colored very fine sandy to light silty loam about 15 inches deep. The subsoil consists of a drab to yellow compact fine silty sand. The type is of alluvial origin and occurs as the immediate banks or as narrow, low-lying, nearly level first bottoms along the courses of streams. The drainage is excellent and the type is fairly well adapted to general farming, and especially well suited to the production of early vegetables, potatoes, berries, and hops. Oats yield from 75 to 100 bushels, hay from 2½ to 3½ tons, potatoes from 300 to 400 bushels, and hops from 1 to 1¼ tons per acre.

	1	2	3	4	5	6	7
Soil (2)	0	1	0	5	23	58	13
Subsoil (2)	0	0	2	36	36	20	6

	Acres.
Everett, Wash	8,448

Sacramento clay loam.—This is a dark-brown or nearly black heavy silty clay loam, containing much well-decomposed organic matter. The soil is generally about 30 inches in depth, and is underlain by light-buff fine sandy loam, and silt loams. It is free from gravel and has a dense, adobelike structure, but is generally friable under cultivation. The type has been formed by an intimate mixture of fine river sediments

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[a] Mapped as Santiago sandy loam.

with well-decomposed peaty and other organic matter. It covers extensive areas of level swamp and overflow lands of stream deltas, and grades insensibly into adjacent peat and adobe lands. It supports a heavy growth of trees, willows or tules, or other swamp vegetation. The soil is very productive when artificially drained and protected from tidal or flood waters. It is devoted to grains, grain hay, timothy or other grasses, potatoes, onions, beans, etc.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	2	6	40	50
Subsoil (1)	1	1	0	9	26	46	17

	Acres.
Stockton, Cal	41,088

Puget clay.—The soil of the Puget clay consists of 15 inches of a drab clay containing a high percentage of partially decomposed organic matter which gives to the soil a loamy, silty feel. The subsoil is a bluish-gray silty clay or clay. The surface is very flat and the cultivated areas are under dike to keep out the high tides and storm floods. The soil has been formed by the deposition of fine alluvial sediments as river bottom or delta tide flats with addition of organic matter from the growth of salt grass, etc. The type is planted almost exclusively to oats, and remarkably large yields are secured. Hay and potatoes also do well.

	1	2	3	4	5	6	7
Soil (3)	0	1	1	2	4	48	44
Subsoil (3)	0	1	1	1	5	54	38

	Acres.
Everett, Wash	25,792
Island County, Wash	768

Salinas gray adobe.[a]—The soil is a dark-gray, dark-brown or nearly black adobe, generally of fine silty clay loam texture, sometimes carrying considerable fine gravel. It is from 30 inches to 6 feet or more in depth, and is usually underlain by a fine sandy loam or fine sand, and occasionally by coarse sand and gravel or disintegrating rock. The type occurs about the edge of foothills and extends into the bottom lands. It seems to be derived largely from granitic material, is retentive of moisture, and is adapted to barley and other grains and sugar beets. Where favorably situated it is adapted to grapes, fruits, vegetables, etc. This is an excellent, loose, friable soil, if irrigated and properly cultivated, but

[a] See, also, Hanford clay adobe, p. 260.

assumes a dense, compact, refractory structure if allowed to bake. It is generally free from alkali.

	1	2	3	4	5	6	7
Soil (7)	1	3	3	9	11	36	33
Subsoil (5)	1	3	11	18	10	30	27

	Acres.
Lower Salinas Valley, Cal	18,400
San Bernardino, Cal	6,912
San Jose, Cal	39,232

HUMUS SOILS.

Peat.—This is vegetable matter consisting of roots and fibers, moss, etc., in various stages of decomposition, occurring as turf or bog, usually in low situations, always more or less saturated with water, and representing an advanced stage of swamp with drainage partially established.

	Acres.		Acres.
Bigflats, N. Y.	576	Santa Ana, Cal	787
Island County, Wash	4,096	Stockton Cal	107,584
Los Angeles, Cal	1,088	Tangipahoa Parish, La	59,200
Newton County, Ind	10,368	Tazewell County, Ill	1,664
San Bernardino, Cal	704	Wooster, Ohio	4,480

Muck.[a]—This type consists of black more or less thoroughly decomposed vegetable mold from 1 to 3 feet or more in depth and occupying low, damp places, with little or no natural drainage. Muck may be considered an advanced stage of peat brought about by the more complete decomposition of the vegetable fiber and the addition of mineral matter through deposition from water or from æolian sources, resulting in a finer texture and closer structure. When drained, muck is very productive and is adapted to corn, potatoes, cabbage, onions, celery, peppermint, and similar crops.

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[a] See also Meadow, p. 270.

	Acres.		Acres.
Allegan County, Mich	33,770	Marshall County, Ind	24,768
Alma, Mich	10,816	Munising, Mich	20,480
Auburn, N. Y	512	New Orleans, La	21,056
Binghamton, N. Y	128	Owosso, Mich	6,400
Carlton, Minn	17,408	Oxford, Mich	15,424
Cleveland, Ohio	768	Pontiac, Mich	3,904
Cerro Gordo County, Iowa	12,096	Portage County, Wis	128,640
Everett, Wash	11,968	Raleigh to Newbern, N. C	623
Gainesville, Fla	128	Saginaw, Mich	30,784
Grand Forks, N. Dak	6,592	Superior, Wis	47,808
Janesville, Wis	10,368	Syracuse, N. Y	16,960
Lyons, N. Y	3,840	Tippecanoe County, Ind	1,664
Madison County, Ind	1,152	Vergennes, Vt.-N. Y	384
Madison, County, Ky	320	Winnebago County, Ill	2,176

UNCLASSIFIED MATERIALS.

There are certain conditions of soil, or in many areas even local absences of true soil, which do not readily fall into any general classification. They may be due to excessive erosion, to overflow, to insufficient drainage, or to wind action, or the soils may be nonagricultural on account of their texture or their present topographic position. Areas of this kind are embraced under the following headings:

Rock outcrop.—This term is used to designate areas consisting of rock ridges, exposed rock outcrops, or accumulations of stone entirely unfit for cultivation and incapable of becoming agricultural land.

	Acres.		Acres.
Allen County, Kans	870	Mount Mitchell, N. C	5,184
Asheville, N. C	1,856	Parsons, Kans	2,368
Austin, Tex	25,408	Pikeville, Tenn	14,016
Baker City, Oreg	192	Superior, Wis	5,632
Bedford, Va	17,140	Vergennes, Vt.-N. Y	43,008
Campobello, S. C	1,997	Waco, Tex	2,880
Carlton, Minn	3,840	York County, S. C	128
Island County, Wash	256		

Rough stony land.—Under this heading have been classed areas so stony and broken as to be nonarable, although permitting timber growth and use for pasturage. These areas frequently consist of steep mountain ridges, bluffs, or narrow strips extending through definite soil types. These areas differ from rock outcrop by supporting vegetation of economic value and from the stony loams in being nonarable.

	Acres.		Acres.
Adams County, Pa	30,976	Munising, Mich	17,344
Alleu County, Kans	12,211	O'Fallon, Mo	30,208
Austin, Tex	[a] 896	Sacramento, Cal	19,839
Brown County, Kans	17,088	Salt River Valley, Ariz	[c] 1,804
Chester County, Pa	8,320	Superior, Wis	6,592
Carlton, Minn	5,440	Tompkins County, N. Y	17,856
Dubuque, Iowa	[b] 60,672	Upshur County, W. Va	48,512
Garden City, Kans	8,768	Warren County, Ky	2,176
Johnson County, Ill	16,384	Webster County, Mo	3,200
Madison County, Ky	1,728	Wichita, Kans	[b] 4,352
Montgomery County, Pa	6,656	Yuma, Ariz.-Cal	6,080

Dunesand.—The Dunesand consists of loose, incoherent sand forming hillocks, rounded hills, or ridges of various heights. The dunes are found along the shores of lakes, rivers, or oceans and in desert areas. They are usually of no agricultural value on account of their irregular surface, the loose, open nature of the material, and its consequent low water-holding capacity. The dunes are frequently unstable and drift from place to place. The control of these sands by the use of wind-breaks and binding grasses is frequently necessary for the protection of adjoining agricultural lands. In certain regions, when leveled and placed under irrigation, the Dunesand is adapted to the production of truck crops and small fruits.

	1	2	3	4	5	6	7
Soil (7)	0	5	27	55	10	0	3
Subsoil (3)	0	1	10	72	14	0	3

	Acres.		Acres.
Allegan County, Mich	3,130	Lower Arkansas Valley, Colo	3,328
Garden City, Kans	83,200	Munising, Mich	7,424
Imperial, Cal	116,288	Rhode Island	128
Indio, Cal	8,256	Superior, Wis	1,536
Kearney area, Nebr	21,312	Ventura, Cal	2,020
Los Angeles, Cal	3,264		

Sandhill.—This term is used to describe ridged and uneven areas of sand not in motion, either on account of partial consolidation or because of the sand being fixed by a natural growth of trees or grasses. Such areas sometimes represent old shore lines of the oceans or large lakes and are sometimes formed by river action and by wind. The material is

[a] Mapped as Yakima stony clay.
[b] Mapped as Clarksville stony loam.
[c] Mapped as Salt River gravel.

incoherent and is generally so thoroughly drained as to be of little agricultural value. Included valleys and low areas, where organic matter and sufficient moisture are present, are capable of producing fair crops of vegetables.

	1	2	3	4	5	6	7
Soil (3)	4	25	25	34	8	3	2
Subsoil (1)	5	28	28	29	5	2	2

	Acres.		Acres.
Darlington, S. C	30,656	Orangeburg, S. C	256
Leon County, Fla	42,752	Raleigh to Newbern, N. C	5,320

Riverwash.—Sand, gravel, and bowlders, generally in long, narrow bodies, but occasionally spread out in fan-shaped areas. These areas occupy river bottoms or flood channels, and occur where the streams are intermittent or liable to torrential overflow. Of no agricultural value.

	Acres.		Acres.
Bakersfield, Cal	6,464	Salt River Valley, Ariz. (No measurement.)	
Blackfoot, Idaho	1,792	San Bernardino, Cal	27,008
Fresno, Cal	480	San Gabriel, Cal	16,230
Jamestown, N. Dak	17,408	San Jose, Cal	128
Kearney, Nebr	33,984	Sevier Valley, Utah	1,300
Laramie, Wyo	1,792	Solomonsville, Ariz	256
Los Angeles, Cal	1,664	Tippecanoe County, Ind	832
Lower Arkansas Valley, Colo	12,800	Ventura, Cal	13,610
Lower Salinas Valley, Cal	10,760	Webster County, Mo	1,856
Madison County, Ky	128	Yakima, Wash	3,580
Sacramento, Cal	778		

Gypsum.—The surface consists of a light-brown or reddish-brown sandy loam or loam underlain by soft saccharoidal gypsum at a depth of from a few inches to 6 feet. Gypsum is often present at the surface. The type occupies level bench land. It is derived from disintegration of gypsum deposits and possesses remarkable power of transmitting seepage waters by capillary and gravitational flow. Where the irrigation water possesses a high salt content this is not a desirable land for agricultural purposes. It often contains large quantities of alkali.

	1	2	3	4	5	6	7
Soil (3)	0	0	2	9	30	29	25
Subsoil (6)	0	1	2	8	18	18	48

	Acres.
Laramie, Wyo	2,304
Pecos Valley, N. Mex	[a] 11,630

[a] Mapped as Pecos gypsum.

Madeland.—Areas are occasionally encountered where filling has taken place over considerable tracts. The arrangement of the materials in these places is artificial and does not fit into any soil classification. In many instances such areas are extensive, and although they are usually of no present agricultural value they should be represented by a color on the map.

	Acres.
Syracuse, N. Y	576

Meadow.—This term is used to designate low-lying, flat, usually poorly drained land, such as may occur in any soil type. These areas are frequently used for grass, pasturage, or forestry, and can be changed to arable land if cleared and drained. The present character of Meadow is due to lack of drainage, and the term represents a condition rather than a classification according to texture. Textural variations frequently occur in Meadow areas on a scale too small to permit of detailed mapping. In many areas the term "Meadow" has also been used to represent small bodies of bottom land occasionally or frequently subject to overflow, which are normally placed under cultivation and constitute land of high value for the production of various general farm crops. Within these bottoms the soils vary frequently in texture, even within small areas, and on account of occasional overflow the character of the soil at any one point is subject to change. The use of this term should be avoided wherever it is possible to separate such areas into distinct soil types.

	Acres.		Acres.
Abbeville, S. C	6,336	Bedford, Va	3,530
Adams County, Pa	3,648	Bigflats, N. Y	1,920
Alamance, N. C	4,960	Biloxi, Miss	17,600
Albemarle, Va	40,640	Blount County, Ala	9,216
Allegan County, Mich	15,510	Calvert, Md	15,800
Alma, Mich	6,592	Campobello, S. C	8,691
Anderson County, Tex	56,640	Carlton, Minn	5,248
Appomattox County, Va	5,760	Carrington, N. Dak	16,064
Asheville, N. C	7,808	Cary, N. C	3,180
Ashtabula, Ohio	12,160	Cerro Gordo County, Iowa	3,456
Auburn, N. Y	8,000	Cherokee County, S. C	6,208
Bainbridge, Ga	14,336	Chester County, Pa	20,480
Baker City, Oreg	[a] 12,352	Cleveland, Ohio	704
Bear River, Utah	448	Cobb County, Ga	30,280

[a] Mapped as muck.

	Acres.
Connecticut Valley, Conn.-Mass [a]	74,852
Covington, Ga	16,410
Crystalsprings, Miss	3,328
Dallas County, Ala	11,584
De Soto Parish, La	72,448
Dodge County, Ga	19,584
Dover, Del	4,096
Dubuque, Iowa	4,160
East Baton Rouge Parish, La	17,408
Fort Valley, Ga	4,800
Fresno, Cal	5,478
Gadsden County, Fla	52,224
Grand Island, Nebr	28,544
Greeneville, Tenn	17,216
Hanover County, Va	15,552
Harford County, Md	4,440
Hickory, N. C	23,872
Houston County, Tex	52,864
Huntsville, Ala	42,240
Jackson, Miss	60,736
Jacksonville, Tex	2,624
Jamestown, N. Dak	4,992
Janesville, Wis	18,112
Kearney, Nebr	46,272
Kent County, Md	49,230
Lancaster County, Pa	6,000
Lancaster County, S. C	11,392
Lebanon, Pa	4,780
Lee County, Tex	13,760
Leesburg, Va	18,048
Leon County, Fla	25,216
Lockhaven, Pa	896
Long Island, N. Y	16,768
Louisa County, Va	11,520
Lufkin, Tex	4,288
Lyons, N. Y	35,008
Macon County, Ala	19,328
McNeill, Miss	6,976
Madison County, Ind	10,816
Marshall, Minn	448
Marshall County, Ind	6,784
Mason County, Ky	832
Mobile, Ala	78,528
Montgomery County, Ala	10,944
Montgomery County, Ohio	7,200
Montgomery County, Pa	3,328
Mount Mitchell, N. C	6,976
Nacogdoches, Tex	5,056
Ouachita Parish, La	13,440
Owosso, Mich	2,688
Oxford, Mich	4,992
Perry County, Ala	53,696
Pontiac, Mich	4,032
Prince Edward, Va	19,830
Prince George County, Md	30,870
Pecos Valley, N. Mex	[b] 7,940
Raleigh to Newbern, N. C	6,330
Rhode Island	1,920
Saginaw, Mich	16,000
St. Mary County, Md	54,200
Salem, N. J	52,250
Saline County, Mo	3,584
Salt Lake, Utah	[c] 6,840
Sevier Valley, Utah	10,200
Shelby, Mo	36,416
Smedes, Miss	17,408
Spalding County, Ga	9,472
Statesville, N. C	18,850
Story County, Iowa	18,048
Sumter County, Ala	21,952
Tangipahoa Parish, La	55,936
Tompkins County, N. Y	8,128
Trenton, N. J	14,800
Upshur County, W. Va	11,008
Vergennes, Vt. and N. Y	3,968
Viroqua, Wis	7,104
Weber County, Utah	7,700
Westfield, N. Y	4,990
Willis, Tex	1,510
Winnebago County, Ill	41,800
Woodville, Tex	5,568
Yakima, Wash	15,060
Yazoo, Miss	4,760
York County, S. C	14,720

[a] Mapped as Connecticut meadows. Should probably have been given a type name, as it is an alluvial soil rather than Meadow in the sense in which this term is used.

[b] Mapped as Hondo meadows. This name will not be used hereafter.

[c] Mapped as Jordan meadows. This name will not be used hereafter.

Swamp.—This term is used to designate areas too wet for any crop and covered with standing water for much or all of the time. Variations in texture and in organic matter content may occur. Swamp frequently occupies areas which are inaccessible, so that detailed mapping is impossible. The native vegetable growth consists of water-loving grasses, shrubs, and trees. Many areas of swamp are capable of drainage, and when this is properly accomplished they not infrequently constitute lands of high agricultural value. Wherever small areas of swamp occur within a definite soil type and the texture of the soil is known to be the same as that of the surrounding type, they should be mapped with the type and the swampy condition shown by symbol.

	Acres.		Acres.
Acadia Parish, La	1,728	Miller County, Ark	2,240
Billings, Mont	3,008	Newton County, Ind	3,648
Binghamton, N. Y	1,024	Norfolk, Va	12,928
Calvert County, Md	3,600	Orangeburg, S. C	40,448
Craven, N. C	188,288	Perquimans and Pasquotank counties, N. C	57,536
Crystalsprings, Miss	3,072	Pontiac, Mich	704
Connecticut Valley, Conn.-Mass	[a] 39,686	Raleigh to Newbern, N. C	[b] 77,440
Dallas County, Ala	8,192	Rhode Island	27,008
Darlington County, S. C	14,144	St. Mary County, Md	2,200
De Soto Parish, La	2,048	Saginaw, Mich	1,344
Duplin County, N. C	109,824	Syracuse, N. Y	12,480
Dover, Del	3,712	Vergennes, Vt. and N. Y	2,048
Everett, Wash	6,080	Worcester County, Md	26,048
Hanover County, Va	6,208	Yorktown, Va	26,368
Leon County, Fla	2,816		
Lower Arkansas Valley, Colo.	640		

Marsh.—This term is used to designate low, wet, treeless areas, usually covered by standing water and supporting a growth of coarse grasses and rushes. These marsh areas occur around the borders of fresh-water lakes and the lower courses of streams. They can seldom be drained without diking and pumping. When this is done the soil is usually productive.

	Acres.
Munising, Mich	704
Tangipahoa Parish, La	3,072

[a] Mapped as Connecticut swamp.

[b] Part of this mapped as Pocoson and part Savanna in the original report.

PORTO RICAN SOILS.

Riverwash.—Coarse sand, gravel, and bowlders, generally in long, narrow areas, but occasionally spread out in fan-shaped areas, subject to overflow in times of flood. Of little or no agricultural value.

	Acres.
Arecibo to Ponce, P. R.	970

Portugues stony loam.—Dark loam 14 inches in depth, derived from igneous and volcanic rocks. Contains 5 to 70 per cent of angular stones, and is underlain by cracked and broken volcanic and igneous rock partly decomposed. Occupies steep slopes of hills and mountains, covering a large area between Ponce and Adjuntas. Used for pasture during the rainy season. Some coffee, bananas, and plantains are produced on favored areas.

	1	2	3	4	5	6	7
Soil (2)	15	15	7	12	9	24	18

	Acres.
Arecibo to Ponce, P. R.	15,600

Tanama stony loam.—Soil is a red clay loam, 6 to 10 inches deep, derived from limestone. Occupies large areas of broken and rugged country between Arecibo and Utuado, characterized by local, swampy sink holes. Subsoil is a stiff red clay containing limestone fragments. Bananas and plantains are the principal crops, and some coffee, oranges, and a little tobacco are produced.

	1	2	3	4	5	6	7
Soil (3)	0	3	3	11	7	31	44
Subsoil (2)	0	3	8	27	6	16	40

	Acres.
Arecibo to Ponce, P. R.	41,680

Arecibo sand.—A loose, incoherent red to white coral and quartz sand, 12 to 36 inches or more deep. Occupies slightly rolling land. Soil is probably derived from wind-blown beach sand. Naturally poor soil. Similar to the Florida pineapple land. Produces some pasturage and a few cocoanuts.

	1	2	3	4	5	6	7
Soil (2)	0	13	41	36	6	3	1
Subsoil (1)	0	8	27	49	8	4	4

	Acres.
Arecibo to Ponce, P. R.	7,580

Coral sand.—Drifted, incoherent beach sand, 24 to 36 inches deep, formed from coral and shells by wind and wave action, underlain by a slightly loamy sand. Occupies low-lying lands on coast, occasionally forming slight hills 15 to 20 feet above sea level. Adapted to cocoanut trees.

	1	2	3	4	5	6	7
Soil (3)	3	27	33	25	5	4	4
Subsoil (1)	4	20	22	26	9	9	10

	Acres.
Arecibo to Ponce, P. R.	2,620

Arecibo sandy loam.—Heavy red sandy loam, with an average depth of 10 inches, underlain to a depth of 36 inches by a rather tenacious clay loam. Found in valleys between outlying limestone hills. Elevation between 30 and 100 feet. Naturally well drained. Used for truck and fruit. Small area devoted to tobacco and sugar cane.

	1	2	3	4	5	6	7
Soil (1)	0	5	18	51	6	6	14
Subsoil (1)	0	4	14	42	6	9	25

	Acres.
Arecibo to Ponce, P. R.	2,690

Ponce sandy loam.—Brown sandy loam 14 to 36 inches or more in depth. An alluvial soil occupying river deltas in the vicinity of Ponce. The subsoil is a sandy loam heavier and darker than soil. Sugar cane is the principal crop. Cocoanuts and Guinea grass also grown. There is a stony phase containing rounded stone fragments, sometimes as large as 2 or 3 feet in diameter. This phase is used only for pasture and at present has little value.

	1	2	3	4	5	6	7
Soil (6)	2	4	5	21	21	35	12
Subsoil (2)	0	0	0	7	16	57	20

	Acres.
Arecibo to Ponce, P. R.	6,550

Utuado sandy loam.—Coarse yellow sandy loam, 7 inches deep, representing soil of deforested area on steep slopes of the lower mountains around Utuado. Residual soil derived from igneous rocks. Subsoil is a shallow yellow sandy loam, grading into decomposed granite and other igneous rocks. Little natural fertility, and but little used, as a great part of the areas are too steep for cultivation.

Should be reforested. Produces a few bananas, some plantains, and coffee.

	1	2	3	4	5	6	7
Soil (1)	20	20	9	15	9	19	8
Subsoil (1)	18	21	9	15	11	17	8

	Acres.
Arecibo to Ponce, P. R.	25,100

Vivi sandy loam.—Yellowish-brown sandy loam, 10 inches deep, forming tracts of alluvial deposits along the larger streams in the mountains near Adjuntas. Subsoil is a yellow-brown sandy loam. Soil is mellow and rich and easy to cultivate. Considered the best tobacco soil in the area. Also adapted to sweet potatoes, beans, and other minor crops. Used to a small extent in the production of sugar.

	1	2	3	4	5	6	7
Soil (2)	1	9	18	35	15	14	9
Subsoil (2)	0	5	8	26	18	25	18

	Acres.
Arecibo to Ponce, P. R.	1,060

Arecibo loam.—A dark waxy loam, 6 to 12 inches deep, resting on a yellow sticky loam containing fragments of limestone. The soil is shallow as a rule, but fairly productive. Principally used for pasture near the coast. Inland areas devoted to bananas, plantains, and to some extent to coffee. A few orange trees were noticed, and appeared to be thrifty. Hardly 10 per cent of the area is in crops.

	1	2	3	4	5	6	7
Soil (2)	5	11	10	21	10	25	19
Subsoil (2)	4	9	9	18	8	26	26

	Acres.
Arecibo to Ponce, P. R.	17,700

Pastillo loam.—White, reddish, or brown loam, about 4 inches in depth, resting on porous limestone, fragments of which occur in soil. Affords scanty pasturage. Produces small amount of Guinea grass on areas of deeper and more fertile soil. Occurs west of Ponce, in the southern part of the Porto Rican area. Among the poorest soils of the area.

	1	2	3	4	5	6	7
Soil (2)	5	5	3	8	9	45	25

	Acres.
Arecibo to Ponce, P. R.	16,040

Ponce loam.—Is composed of a dark-brown alluvial loam, 3 feet or more in depth. Originally swampy in part. When drained, well adapted to sugar cane and Guinea grass, also to bananas and plantains. Best sugar land of the area. All under cultivation.

	1	2	3	4	5	6	7
Soil (1)	0	1	1	5	15	57	20

	Acres.
Arecibo to Ponce, P. R.	2,480

Utuado loam.—Dark-brown or yellowish loam, 7 inches deep, friable and free from stones, underlain by yellow loam, becoming lighter in texture at lower depths. Derived from igneous and volcanic rocks. Occupies hilly country in vicinity of Utuado. Some areas adapted to coffee and fruit, but the greater part used for pasture.

	1	2	3	4	5	6	7
Soil (1)	2	5	5	16	11	28	34
Subsoil (1)	1	3	6	20	10	30	30

	Acres.
Arecibo to Ponce, P. R.	7,880

Arecibo silt loam.—Dark-brown silt loam, 12 to 36 inches deep, underlain by dark loam or silt loam. Alluvial deposit occupying low, level areas along or near the coast. In the vicinity of Arecibo excellent cane land, producing from 30 to 40 tons per acre. Around Ponce low lying and too alkaline for crops, on account of occasional inundation by sea water.

	1	2	3	4	5	6	7
Soil (4)	1	1	1	8	10	55	24
Subsoil (3)	1	1	1	6	8	52	31

	Acres.
Arecibo to Ponce, P. R.	8,960

Alonso clay.—Dark purplish-red clay loam, 8 to 28 inches deep, underlain by dark to purplish-red tenacious clay 36 inches or more in depth. Derived from igneous and volcanic rocks. Heavy, stiff, and hard to cultivate. Rough, mountainous topography. The small area southwest of Adjuntas is well adapted to oranges and coffee. The other areas are lower and produce chiefly bananas and plantains, with some coffee.

	1	2	3	4	5	6	7
Soil (5)	3	4	4	10	11	31	37
Subsoil (2)	0	2	2	9	7	37	43

	Acres.
Arecibo to Ponce, P. R.	13,690

Adjuntas clay.—A red or dark-brown clay, 3 to 15 inches deep, underlain by red clay 36 inches or more in depth. Derived from volcanic and igneous rocks. Occupies steep slopes. Difficult or impossible to till, requiring great care to prevent washing. The principal and most important coffee soil of the Arecibo to Ponce area. Also adapted to the growth of bananas, plantains, and oranges where there is a sufficient depth of soil.

	1	2	3	4	5	6	7
Soil (3)	1	1	1	4	5	36	52
Subsoil (2)	0	1	1	5	6	44	43

	Acres.
Arecibo to Ponce, P. R.	29,890

Penuelas adobe.—Brown loam, with marked adobe properties, 13 to 15 inches deep, underlain by cracked and broken volcanic tufa. Derived from disintegrated volcanic tufa. Occupies hills and gentle slopes around Penuelas. Too dry except for pasture. Some bananas grown on moist spots.

	1	2	3	4	5	6	7
Soil (2)	4	6	4	9	9	27	41
Subsoil (1)	30	21	8	13	9	9	9

	Acres.
Arecibo to Ponce, P. R.	6,680

Portugues adobe.—Heavy, dark-brown or black loam resembling adobe, 6 to 17 inches deep, formed from decomposed limestone. Occupies parting valleys and gentle slopes around limestone hills in southern part of area. Soil is underlain by heavy light-brown loam, becoming lighter in color with increasing depth. Devoted chiefly to pasture, but produces sugar cane and bananas where irrigation is practicable. A large part of the area lies too high for irrigation.

	1	2	3	4	5	6	7
Soil (2)	1	3	2	7	13	41	33
Subsoil (2)	1	3	1	4	10	43	38

	Acres.
Arecibo to Ponce, P. R.	4,010

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PORTO RICAN SOILS.

SOILS ARRANGED BY STATES.

REFERENCES TO SOIL SURVEY REPORTS.

Following the description of the type is a list of locations in which the soil has been mapped. For convenience in referring to the original description of the soil, an alphabetical list of all areas surveyed by the Bureau is here given, with a reference showing the number of the volume and the page where the description occurs. The volume reference is to the different reports: **1** (Report 64), Field Operations, Bureau of Soils, 1899; **2**, 1900; **3**, 1901; **4**, 1902; **5**, 1903; **6**, 1904; **7**, 1905.

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